



DRAFT

Biological Monitoring Goldsborough Creek, Washington 2003 Spawning and Macroinvertebrate Surveys



Prepared for:
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July 2004

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Data Report**

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1. INTRODUCTION

Goldsborough Creek, located in the foothills of the southern Olympic Peninsula, Washington, is the site of a Section 206 Restoration Project conducted under the authority of the Water Resources Development Act by the U.S. Army Corps of Engineers, Seattle District (USACE). The Goldsborough Creek Restoration Project entailed the removal of a dam located at River Mile (RM) 2.3. The stream in the vicinity of the dam was stabilized to establish a gradual drop over several thousand feet of stream (Tetra Tech 1999). The objective of the project is to re-establish an upstream and downstream connection for anadromous salmon between upper Goldsborough Creek and South Puget Sound (USACE 1999a). The Goldsborough Creek Project was completed in September of 2001.

Goldsborough Creek is located near the City of Shelton, south of Hood Canal in Mason County, Washington. Goldsborough Creek (WRIA 14.0035) is approximately 14 mi long and has a drainage basin of approximately 55 mi² (Williams et al. 1975; USFWS 1999; USACE 1999a). The headwaters for Goldsborough Creek originate from several small spring-fed lakes that supply water to the North and South forks (Figure 1). Mean monthly discharge ranges from a low of 20 cfs in September to 400 cfs in February (mean annual discharge = 117 cfs) (Williams et al. 1975). Most of the upper drainage basin is composed of second growth timber, while the lower basin (i.e., downstream from RM 2) flows through the City of Shelton before emptying into Oakland Bay. The two largest tributaries, Coffee and Winter creeks, are located near RM 1.7 and RM 9.0, respectively. Coffee Creek is approximately 2.1 mi long and enters Goldsborough Creek near Shelton; Winter Creek, 4.5 mi long, is a tributary to the North Fork of Goldsborough Creek near Wells, Washington.

The original dam on Goldsborough Creek was constructed in the late 1800s by Satsop Railroad to store logs before they were transported downstream to Shelton (Seavey 1999). The updated dam, a 14-ft-high timber-wall dam, was built in 1932 by Rainier Pulp and Paper Company to supply water to their pulp mill that was located in Oakland Bay (Figure 2). The original dam was constructed with a fishway; however, it became inoperable over time due to erosion downstream from the dam. Additional structures (i.e., sheet pile weir and timber piles) were added to the dam to create a “four-step” structure (USACE 1999a). The spillway discharged onto a shallow, concrete-lined pool/step and then dropped another 15 ft into a plunge pool (Figure 2). Modifications to the original structure in 1932 also included a new fishway located on the left side of the stream. Total vertical displacement through the dam from the crest to the plunge pool was approximately 35 ft. Like the old facility, the updated fishway appeared to prevent upstream migration of chum salmon (*Oncorhynchus keta*) and restrict the upstream movement of coho (*O. kisutch*) under certain hydraulic conditions (Seavey 1999; USACE 1999a).

The Goldsborough Creek Restoration Project consisted of the following tasks: removal of the timber pile and concrete structure; excavation of approximately 25,000 yd³ of sediment deposited upstream of the dam; placement of fill material downstream of the dam to re-

establish channel gradient; construction of weirs within the area currently occupied by the dam to control gradient and provide velocity refugia for upstream migrating salmonids; and bank protection/revegetation activities. The project was a collaborative effort between the USACE and Simpson Timber Company under Section 206 of Water Resources Development Act. Feasibility studies were completed in 1999 and the project received approval in September 1999 by the USACE, North Pacific Division. The project construction was completed by the fall of 2001 (Figure 3). Bank protection and revegetation activities are still ongoing.

There are 36 weirs in the Project Area (i.e., downstream-most weir to upstream-most weir) arranged in six groups of five and one group of six (the downstream-most weir group). There is approximately 35 ft between individual weirs, and each weir group is separated by 100 to 275 linear ft of stream channel. The overall slope of the Project Area is designed to be 2.3%, with approximately 3.6% slope within each weir (USACE 1999b). Each weir is designed to provide unhindered upstream and downstream fish passage at varying flow levels (Figures 4 and 5). Each weir is designed to have a maximum 12 inch elevation drop to ensure fish passage. During project construction Goldsborough Creek was routed around the Project Area through a temporary bypass pipe. A stilling basin was placed at the bypass pipe outlet to serve as a sediment trap. After the bypass pipe was in place, a concerted effort was made to collect and transport as many fish as possible out of the dewatered Project Area. When the pipe was removed, the stilling basin was left to continue to filter sediments being flushed downstream by the return of the creek to its channel.

The USACE contracted with R2 Resource Consultants (R2), to conduct biological monitoring in Goldsborough Creek. The primary objective of this study is to obtain pre- and post-dam removal data on the timing and distribution of salmon spawning in Goldsborough Creek. Specifically, the scope of work identified three tasks:

- Conduct spawner surveys in Goldsborough Creek during the chum, coho, and Chinook (*O. tshawytscha*) salmon spawning season;
- Collect benthic macroinvertebrates from three index reaches in Goldsborough Creek for comparison with pre-dam removal metrics; and
- Prepare a biological monitoring data report, describing both the number of fish observed as well as the pre- and post-dam removal benthic macroinvertebrate information collected from Goldsborough Creek in 2003.

The following report describes the methods and results of the biological monitoring. We have included descriptions of the physical conditions (water clarity, water temperature, and stream discharge) in the survey reaches and incorporated the results of previous adult spawner surveys to facilitate comparisons over time. This report will help assess the success of the Goldsborough Creek Restoration Project relative to upstream fish passage.

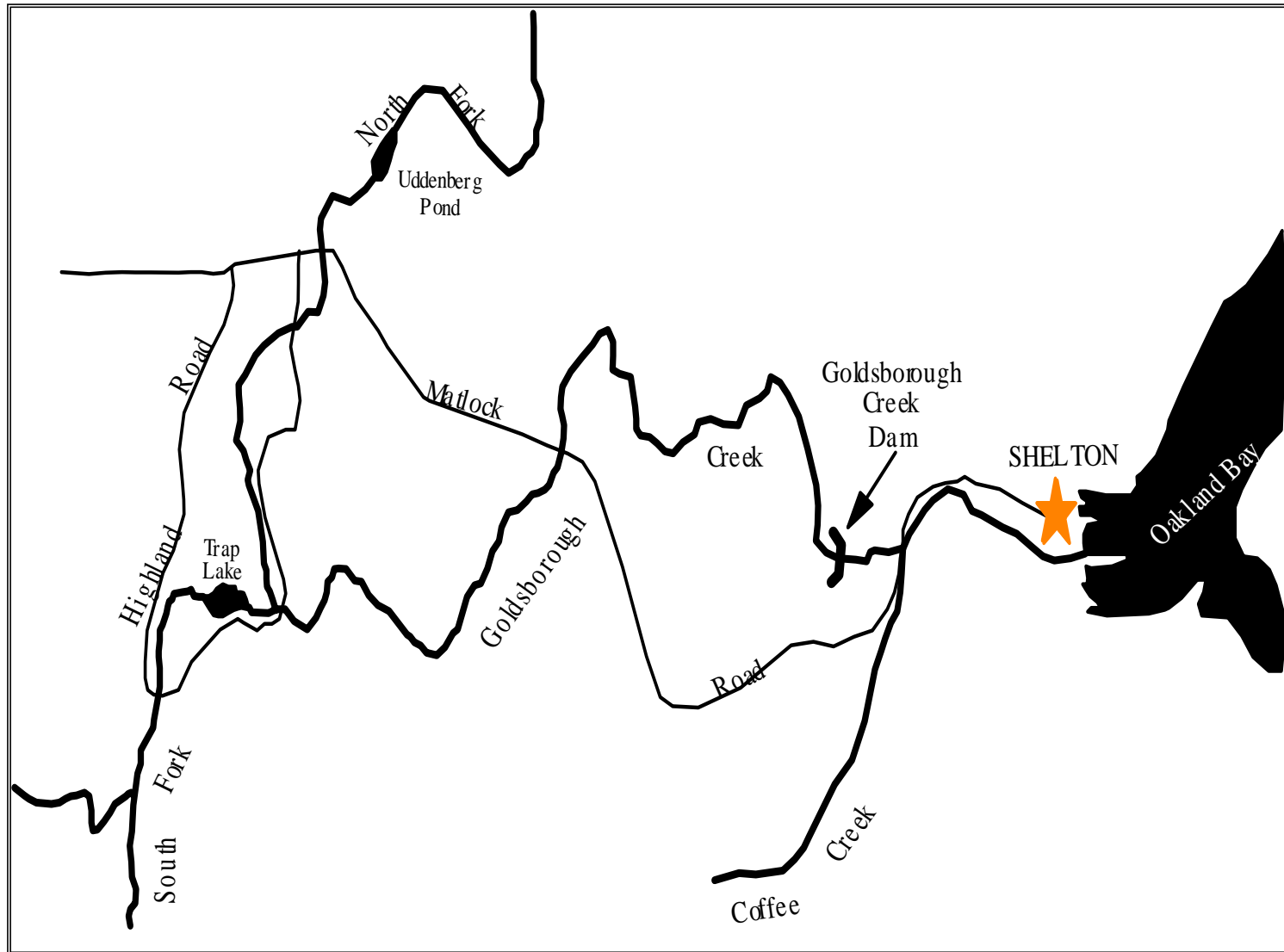


Figure 1. Goldsborough Creek drainage basin, Mason County, Washington (base map adapted from Williams et al. 1975).



Figure 2. Updated Goldsborough Creek Dam, 1999, Mason County, Washington.



Figure 3. Goldsborough Creek Restoration Project Area during construction, August 2001, Mason County, Washington.



Figure 4. Goldsborough Creek Restoration Project Area, low flow conditions, Mason County, Washington.



Figure 5. Goldsborough Creek Restoration Project Area, high flow conditions, Mason County, Washington.

2. BIOLOGICAL SETTING

Goldsborough Creek supports populations of both resident and anadromous fish species. Chum, coho, and Chinook salmon, coastal cutthroat trout (*O. clarki clarki*) and steelhead (*O. mykiss*) are known to spawn in Goldsborough Creek (Williams et al. 1975; Bernard 1999), while bull trout (*Salvelinus confluentus*) are present in many drainages on the Olympic Peninsula (Spalding 1997). The following section describes key life history characteristics and residency periods for each of the aforementioned species.

2.1 CHINOOK SALMON

Chinook salmon are the largest of all Pacific salmon, and can weigh over 100 pounds, however the average weight is closer to 22 pounds. Chinook salmon, the least abundant of the five Pacific salmon species, were historically found from the Ventura River, California to Point Hope, Alaska (Meyers et al. 1998). Presently, spawning populations of Chinook exist from the San Joaquin River, California to the Kotzebue Sound, Alaska (Healey 1991). Chinook salmon are differentiated into two primary juvenile behavioral forms, ocean-type and stream-type, based on their pattern of freshwater rearing. Juvenile ocean-type Chinook salmon migrate to the marine environment during the first year of life, generally within three to four months of emergence (Lister and Genoe 1970). Juvenile stream-type Chinook salmon rear in freshwater for a year or more before outmigrating to the ocean. The population of Chinook salmon in a single river system may exhibit variations in these freshwater rearing strategies depending on annual variations in food supply, water temperature and other environmental factors. Differences between these life history patterns are accompanied by differences in morphological and genetic attributes (Myers et al. 1998). Chinook salmon classification is further divided by the timing of upstream migration (e.g., spring or fall/summer runs).

The principal stock of Chinook salmon present in Goldsborough Creek is summer/fall ocean-type Chinook. Adult summer/fall Chinook migrate upstream from early August to mid-November. Spawning takes place from mid-September through mid-November. The juveniles may migrate to the ocean in the first three months of life. Ocean-type Chinook depend heavily on estuaries for juvenile rearing to achieve a larger size before moving off-shore. Juvenile Chinook (n = 105; mean FL = 79 mm) were captured in a screw trap operated in Goldsborough Creek near RM 0.3 in 2000 (Celedonia et al. 2000).

Goldsborough Creek summer/fall Chinook are part of the Puget Sound Evolutionary Significant Unit (ESU). Overall, abundance of Chinook salmon in this ESU has declined substantially, and both long- and short-term abundances are on predominantly downward trends. These factors have led to this ESU as being listed as threatened under the ESA (64 *Fed. Regist.* 11481:11520).

2.2 COHO SALMON

Coho salmon are one of the most popular and widespread sport fishes found in Pacific Northwest waters. Coho populations exist as far south as the San Lorenzo River, California and north to Norton Sound Alaska (Sandercock 1991). Goldsborough Creek coho appear to be typical of Puget Sound stocks with regard to their life histories; eighteen months in freshwater followed by eighteen months in saltwater (or up to three years) (Weitkamp et al. 1995). Juvenile coho salmon may extend their freshwater rearing period for up to two years or more (Sandercock 1991). Adult coho return and migrate upstream from early September through late January. Spawning occurs from mid-November through late January. All accessible reaches are used for spawning, with mainstem spawning typically heaviest in braided channel reaches.

There have been substantial releases of hatchery-origin coho salmon fry and use of remote site incubators upstream of the Goldsborough Creek Dam starting in 1955 (Weitkamp et al. 1995). Over the years, seven different stocks were used with the majority of the planted coho salmon originating from the George Adams (3.3 million) and Minter Creek (3.2 million) hatcheries. The total number of fish planted between 1955 and 1993 was 6.9 million fish. Between 1993 and 1998 about 100,000 coho salmon fry were stocked annually from Minter Creek and a remote site incubator with 30,000 eggs has operated annually since 1995 (Baranski 1999). However, Washington Department of Fish and Wildlife (WDFW) and the Squaxin Island Tribe have agreed to stop all supplementation activities in Goldsborough Creek during the 8 to 10 year post-dam removal monitoring period, starting in 1998. Baranski (1999) provided adult coho spawner count data from 1978 to 1999 for the index reach upstream of the dam. These data show an average of 419 fish per year (expressed as “fish-days”) with a range from 0 to 1,259 coho, averaging 115 coho for the last 10 years. Juvenile coho ($n = 4,963$; mean FL = 113 mm) were captured in a screw trap operated in Goldsborough Creek near RM 0.3 in 2000 (Celedonia et al. 2000).

Goldsborough Creek coho stocks are considered part of the Puget Sound/Strait of Georgia ESU. Continued loss of habitat, extremely high harvest rates, and a severe recent decline in average spawner size are substantial threats to remaining native coho populations in this ESU. Currently, this ESU is not listed as threatened or endangered.

2.3 CHUM SALMON

Chum salmon, known for the large teeth and calico-patterned body color of spawning males, have the widest geographic distribution of any Pacific salmonid (Johnson et al. 1997). In North America, chum range from the Sacramento River in Monterey, California to Arctic coast streams (Salo 1991). Chum salmon typically return to tributaries in October and November and spawn in the lower reaches of rivers in from early December to early February (WDFW et al. 1994). Juvenile chum salmon, like ocean-type Chinook, have a short freshwater residence and an extended period of estuarine residence, which is the most critical

phase of their life history and often determines the size of subsequent adult returns (Johnson et al. 1997).

Spawning surveys conducted in the mid-1970s found few fall chum salmon, however, recent returns to Goldsborough/Shelton Creek combined have totaled between 200 and 16,000 fish and appears to be stable (WDFW et al. 1994). Based on counts conducted in the index reach below the former dam since 1987, the average spawner count (expressed as “fish-days”) is 3,872, ranging from 405 to 14,479 fish per year. From 1995 to 1998, high fall flows resulted in poor estimates of chum escapement. Nearby Shelton Creek chum are independent of Goldsborough Creek chum salmon, but the two stocks were combined by WDFW based on geographic proximity. Genetic stock identification (GSI) indicates that this combined stock is distinct from other South Puget Sound stocks. These fish spawn from early December to early February, about a month later than other Hammersley Inlet fall chum (Kuttel 2002). Juvenile chum (n = 692) were captured in a screw trap operated in Goldsborough Creek near RM 0.3 in 2000 (Celedonia et al. 2000).

Goldsborough Creek chum salmon are included in the Puget Sound/Strait of Georgia ESU. Commercial harvest of chum salmon has been increasing since the early 1970s throughout this ESU. This increased harvest, coupled with generally increasing trends in spawning escapement, provides compelling evidence that chum salmon are abundant and have been increasing in abundance in recent years within this ESU (Johnson et al. 1997). The National Marine Fisheries Service concluded that this ESU is not presently at risk of extinction, and is not likely to become endangered in the near future (63 *Fed. Regist.* 11778).

2.4 BULL TROUT

Bull trout are native to Pacific Northwest waters, historically occurring from the McCloud River in Northern California to the Yukon River in Northwest Territories, Canada. Bull trout are now considered to be extinct in northern California, and shrinking in distribution throughout its former range. The taxonomic status of bull trout have been confused with that of Dolly Varden. Bull trout were differentiated from Dolly Varden in 1978 (Cavender 1978) and recognized as a separate species by the American Fisheries Society in 1980. Both species are native salmonids and members of the Genus *Salvelinus*. The species are similar in coloration, morphology, and life history, making distinction between the two species difficult without the use of electrophoretic samples or measurements of morphometric characteristics (WDFW 1997). The state of Washington has established identical protective measures and management for the two species (WDFW 1997). Historically, bull trout were thought to be distributed primarily inland as a resident species; however, recently most inland populations have been determined to be Dolly Varden and anadromous populations as bull trout. Spawning in most bull trout populations occurs during the fall, mainly in September and October. The eggs incubate and hatch in late winter or early spring. Juvenile bull trout may remain in freshwater for two to three years (or longer) before migrating to the ocean. Eighteen different populations of bull trout have been identified on the Olympic Peninsula, however little information exists on the presence or absence of bull trout in the Goldsborough

Creek drainage (Spalding 1997). No bull trout were captured in a screw trap operated in Goldsborough Creek near RM 0.3 in 2000 (Celedonia et al. 2000).

Bull trout within the Puget Sound ESU were listed as threatened under ESA (64 *Fed. Regist.* 58911:58932) due to several detrimental factors (including disease, predation, increased stream temperatures, and loss of habitat). Likewise, Dolly Varden were proposed as threatened under ESA due to their similarity of appearance to bull trout (66 *Fed. Regist.* 1628:1632).

2.5 STEELHEAD

Steelhead, displaying perhaps the most diverse life history pattern of all Pacific salmonids, reside in most Puget Sound streams. Their historic native distribution extended from northern Mexico to the Alaska Peninsula. Presently, spawning steelhead are found along the Pacific Coast from as far south as Malibu Creek, California (Busby et al. 1996). Two different genetic groups (coastal and inland) of steelhead are recognized in North America (Busby et al. 1996). Both coastal and inland steelhead occur in British Columbia, Washington, and Oregon; while Idaho stocks are of the inland form and California steelhead stocks are all of the coastal variety (Busby et al. 1996). Within these groups, steelhead are further divided based on the state of sexual maturity when they enter freshwater. Stream-maturing steelhead (also called summer steelhead) enter freshwater in an immature life stage, while ocean maturing (or winter steelhead) enter freshwater with well-developed sexual organs (Busby et al. 1996). Goldsborough Creek steelhead (both summer and winter stocks) have been placed into the Puget Sound ESU, along with 53 other steelhead stocks, by the National Marine Fisheries Service (Busby et al. 1996). Total run size for the major stocks of this ESU was estimated at 45,000; natural escapement was estimated at 22,000 steelhead (Busby et al. 1996).

Winter and summer steelhead runs in Washington are differentiated by the timing of adult returns to freshwater. Adult steelhead entering Goldsborough Creek from November through May are considered winter steelhead (WDFW et al. 1994). Winter steelhead are native to Hammersley Inlet tributaries and spawn from February through early April (WDFW et al. 1994). Escapement of steelhead on Goldsborough Creek is not monitored by WDFW. Historically, Goldsborough Creek has received hatchery steelhead plants, however, WDFW considers any steelhead occurring in Goldsborough Creek a native stock sustained by natural production (WDFW 1994). Juvenile steelhead ($n = 53$; mean FL = 162) were captured in a screw trap operated in Goldsborough Creek near RM 0.3 in 2000 (Celedonia et al. 2000).

Goldsborough Creek steelhead have been classified as part of the Puget Sound ESU (1 of 15 west coast steelhead ESUs). National Marine Fisheries Service indicated that, in general, the entire Puget Sound ESU is not threatened at this time. Future population declines, however, may warrant changes in ESA status (Busby et al. 1996).

2.6 COASTAL CUTTHROAT TROUT

Coastal, or anadromous cutthroat trout, are distributed on the Pacific Coast from Prince William Sound in southern Alaska to the Eel River in northern California, rarely penetrating more than 100 miles inland (Johnston 1982; Behnke 1992). Considerable information exists for Puget Sound cutthroat trout, though little of that has been collected in a standardized manner and over a long enough time period to establish trends in populations (Leider 1997).

Coastal cutthroat trout exhibit early life history characteristics similar to coho and steelhead whereby juveniles spend time rearing in freshwater before outmigrating as smolts (Leider 1997). While little information exists on Goldsborough Creek cutthroat, Puget Sound cutthroat emigrate to estuaries at a younger age (age II) and smaller size (6 inches TL) than cutthroat that are exposed to rough coastal waters (age III to V, 8-10 inches TL) (Johnston 1982). Puget Sound cutthroat trout will feed and migrate along beaches, often in waters less than 10 feet deep (Johnston 1982). Many stocks are thought to stay within estuarine habitats for their entire marine life (Leider 1997). Most cutthroat return to freshwater the same year they migrate to sea. Juvenile cutthroat trout ($n = 222$; mean FL = 155 mm) were captured in a screw trap operated in Goldsborough Creek near RM 0.3 in 2000 (Celedonia et al. 2000).

Goldsborough Creek coastal cutthroat trout have been classified as part of the Puget Sound ESU by the National Marine Fisheries Service (64 *Fed. Regist.* 16397). This ESU includes populations of coastal cutthroat trout from streams in Puget Sound and the Strait of San Juan de Fuca west to, and including, the Elwha River. The southern boundaries of the Puget Sound ESU extend to Nisqually River, while the northern boundaries include coastal cutthroat trout populations in Canada (64 *Fed. Regist.* 16397). The Puget Sound coastal cutthroat trout does not warrant listing under ESA at this time; populations have been relatively stable over the past 10-15 years (64 *Fed. Regist.* 16397).

2.7 RESIDENT FISH

Little information about resident fish is available for Goldsborough Creek. Mongillo and Hallock (1997) examined the distribution and habitat of native nongame stream fishes on the Olympic Peninsula, including the Goldsborough Creek drainage. They concluded that eight nongame fish could potentially inhabit Goldsborough Creek. These fish include the speckled dace (*Rhinichthys osculus*), coastrange sculpin (*Cottus asper*), prickly sculpin (*Cottus perplexus*), reticulate sculpin (*Cottus gulosus*), riffle sculpin (*Cottus gulosus*), Pacific lamprey (*Lampetra tridentata*), three-spine stickleback (*Gasterosteus aculeatus*), and Olympic mudminnow (*Novumbra hubbsi*). Bernard (1999) also captured eulachon (*Thaleichthys pacificus*) in the Goldsborough Creek basin.

3. METHODS

3.1 SPAWNING SURVEYS

Spawning surveys were conducted from 22 August 2003 through 5 February 2004 on Goldsborough Creek. Surveys were scheduled once every two weeks during the study period for a total of 12 survey trips. Five study reaches were surveyed based upon Missildine et al. (1999) and Jeanes and Hilgert (2000). The following index reaches in Goldsborough Creek basin were surveyed during the 2003 spawning season:

- Lower Goldsborough Creek – through and downstream of the Project Area (RM 0.5-2.2);
- Middle Goldsborough Creek – immediately upstream of the Project Area (RM 2.3-3.4);
- Upper Goldsborough Creek – upstream of the Project Area, near Carmen Rd. (RM 5.8-6.7);
- South Fork Goldsborough Creek (RM 9.9-11.0); and
- Coffee Creek (RM 0.0-0.3).

Spawning surveys were conducted by a single observer walking upstream, beginning at the lower site boundary, and proceeding to the upstream end of the survey reach. Newly constructed redds were marked with survey flagging tied to rocks and placed adjacent to observed redds. Subsequent survey weeks utilized flagging of a different color. Total spawner counts on a survey represented all live fish observed and those dead fish not previously counted. Dead fish were marked on each survey by removing the entire caudal fin.

Water temperature (to the nearest 0.5°C) and stage (to the nearest 0.01 ft) were recorded on each survey date using a handheld thermometer and staff gage measurements, respectively. In addition, an Optic StowAway® temperature monitor from the Onset Computer Corporation was used to record hourly instream temperatures at the gage location just upstream from the Highway 101 bridge crossing. Stream discharge measurements were also periodically collected at the stream gage location using a Swiffer Model 2100 velocity meter coinciding with spawner survey days. Representative photographs were taken of individual redds and index reaches.

A supplemental snorkel survey was also performed through the weir section (Project Area) of Goldsborough Creek to assess fish access throughout the Project Area. Two experienced snorkelers surveyed upstream through each weir and enumerated all salmonids observed.

Dive lights were used as needed to assist visibility. An additional observer/recorder was present on the bank during snorkel surveys. All data were transcribed onto field data books, entered electronically using MS Excel, and cross-referenced with original field data books for QA/QC purposes.

3.2 MACROINVERTEBRATE FIELD METHODS

Sampling methods generally followed the Washington Department of Ecology's (Ecology) protocols for benthic macroinvertebrates (Plotnikoff 1994). In October and again in February four samples were collected from each of four survey locations using a D-frame kick-net sampler fitted with 500-micron Nitex mesh. Site locations were selected in an effort to match previous invertebrate sampling performed by the U.S. Fish and Wildlife Service in October 1998 (Missildine et al. 1999). Site 1 is located downstream of the Project Area above the stream gage site. Sites 2 and 3 are within the Project Area, while Site 4 is upstream of the Project Area. Site 5 is the uppermost site near the Highway 101 bridge at Carmen Road. All samples were collected in riffles or shallow runs possessing a substrate consisting of coarse gravel to small cobble. All samples were collected from water depths of approximately 0.5 to 1.0 feet, and mean water column velocities between approximately 1.0 and 3.0 ft per second. Sample locations were randomly selected, although sampling was not conducted at a specific location unless depths and water velocities were within the suitable range specified above. Depths were measured with a top-setting rod and velocities were measured with a Swoffer Model 2100 velocity meter.

Each sample was collected from an area of the stream bottom 1-ft wide (the width of the kick net) and 2-ft long (i.e., 0.19m²). The stream bottom was vigorously disturbed for a period of one minute. Large substrates were scrubbed by hand to dislodge remaining organisms. Substrates were sampled to a depth of approximately 0.2 ft (6.0 cm). The contents of the kick net were transferred into a large tub and the net was backflushed several times with river water to dislodge as many organisms as possible while the rinsate collected in the tub. The contents of the tub were poured through a 500-micron mesh sieve. After rinsing, swirling, and pouring the contents of the tub through the sieve three times, the heavier particles remaining in the bucket were examined and macroinvertebrates and fish noted and removed (e.g., crayfish and sculpin). The contents of the sieve were then emptied into a 16-oz, wide-mouth glass Mason jar with a rubber spatula. The sieve was subsequently rinsed with 86 percent ethyl alcohol and the rinsate was collected in the Mason jar. Any invertebrates still clinging to the kick net mesh were removed with fine point forceps or by hand and placed into the Mason jar. The depth, mean column velocity, substrate composition, and water temperature of each sampling location were transcribed onto field data books, entered electronically using MS Excel, and cross-referenced with original field data forms for QA/QC purposes.

3.3 MACROINVERTEBRATE LABORATORY METHODS

Following field collection the samples were transported to Aquatic Biology Associates, Inc. for processing. The four subsamples were consolidated in a white plastic tray. Large debris was rinsed and removed. The sample was then elutriated until all organic matter and invertebrates were separated from the mineral residue and collected on a 500 micron sieve. The mineral residue remaining in the white pan after elutriation was searched for remaining stone-cased caddisflies and molluscs.

A Caton Tray was used to randomly obtain 500-600 organisms from the total sample. Subsample data was then converted to a full sample basis based on this fraction. Experienced technicians were used to remove all invertebrates from the sample fraction using dissecting scopes at 6X or 12X power. All invertebrates removed were placed in a single sorting vial and given directly to Robert W. Wisseman, Senior Scientist of Aquatic Biology Associates, Inc. for expert identification.

The entire sample residue was saved after sorting to check for sorting efficacy. Sorting efficiency of 95% or better was required on all samples. A 20% aliquot of each residue was thoroughly re-sorted to determine efficacy. The entire residue was re-sorted if 95% or better sorting efficacy had not been achieved, as estimated from the 20% aliquot re-sort. Identifications and counts were recorded on bench-sheets and then transferred to electronic files. The use of standardized bench-sheets reduced data entry errors. Aquatic Biology Associates, Inc. used standard methods outlined by Kleindl (1995) to calculate a benthic invertebrate index of biological integrity and other metrics described below.

Following taxonomic identification and enumeration of each sample, the abundance of each taxonomic group was used to calculate the key biotic metrics. The following are some of the more important metrics and biotic indices that were calculated for each invertebrate sample.

Density – Density is calculated as the number of individuals per unit area (i.e., m²). Density values could be estimated from the samples because they were collected from a standardized sample area (0.19 m²).

Taxa Richness – Taxa richness is the total number of unique macroinvertebrate taxa present in the combined samples. This metric generally increases with enhanced water quality and/or habitat diversity, and it is used as a relative measurement of the health of the benthic invertebrate community.

Mayfly, Stonefly, and Caddisfly (EPT) Taxa Richness – This metric describes the number of distinct taxa within the insect orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). These insect orders are relatively sensitive to habitat disturbance

or water quality degradation and are important items in fish diets. Taxa richness values were also calculated separately for mayflies, stoneflies, and caddisflies because certain human disturbances can decrease the diversity of one order and not the others. The separate taxa richness values generally increase with improving water quality. Consequently, these indicators are widely used for overall stream health.

Intolerant Taxa Richness – Intolerant taxa are known to be sensitive to stream disturbance. For this report, intolerant taxa are defined as sensitive species present in water of sufficient quality (i.e., temperature, oxygenation) to support salmonid rearing.

Long-Lived Taxa Richness – Long-lived taxa are organisms that complete their immature life cycle in more than one year. Because they are long-lived, they are not expected to survive single, catastrophic events that occur infrequently (every one or more years) or to more regular, subtle disturbances that repeatedly interrupt their life cycle. Their presence in a stream suggests a lack of such disturbances. Representative long-lived species include certain mayfly and stonefly species as well as many snails, mussels, and riffle beetles.

Percent Planaria and Amphipoda – Planaria are a type of flatworm that whose presence is indicative of poor water quality conditions. The presence of Amphipoda (scuds) also usually signifies poor water quality conditions.

Percent Tolerant Taxa – Percent tolerant taxa is the relative abundance of all invertebrates in a sample are tolerant to disturbance. For the purposes of this study, tolerant taxa were defined as taxa that are present in unshaded, warm nutrient-enriched streams.

Percent Predator Taxa – Predators feed on living animal tissues or prey. They are the top of the macroinvertebrate food chain and rely on a steady source of other invertebrates or animal tissue for food. Less disturbed sites support a greater diversity of prey items, and thus a higher percentage of predators.

Functional Feeding Group Classification – Each aquatic invertebrate taxon was placed in one of several functional feeding groups, to categorize the trophic status (i.e., food requirements) of the organism. The functional feeding group categories in our analysis were: 1) *grazers (or scrapers)*, which feed upon attached algae or periphyton; 2) *shredders*, which feed upon coarse particulate organic matter (CPOM) such as leaves; 3) *collector-gatherer/collector-filterer*, which feed upon fine particulate organic matter (FPOM) deposits such as detritus; 4) *parasites*, which feed upon living animal tissue; 5) *xylophages*, which feed upon wood; 6) *omnivore*, which feeds on plant and animal tissue; 7) *piercer*, which feed

upon living vascular hydrophyte cell and tissues; and 8) *predators*, that feed on living animal tissue. Robert W. Wisseman, Senior Scientist of Aquatic Biology Associates determined these functional feeding groups.

Modified Hilsenhoff Biotic Index – This index is used to portray the overall pollution tolerance of the benthic invertebrate community as a single value (Barbour et al. 1999). Tolerance values for individual organisms range from 1 to 10, with 1 describing very little or no tolerance to organic pollution and 10 describing high tolerance to organic pollution. The cumulative score for the benthic community results in a water quality and degree of organic pollution rating (Table 1). The Hilsenhoff Biotic Index (HBI) is calculated as:

$$HBI = \sum x_i t_i / n$$

where x_i is number of individuals within a given taxa, t_i is the tolerance value for this taxa, and n the total number of organisms in a sample. The HBI tolerance values for each invertebrate taxonomic group were obtained from Hilsenhoff (1987). The HBI was compared with values determined from samples collected by the Washington Department of Ecology in October 1998 in other local streams.

Table 1. Cumulative HBI scores and the corresponding evaluation of the degree of organic pollution.

Cumulative HBI Score	Degree of Organic Pollution
0.00 to 3.50	No apparent organic pollution
3.51 to 4.50	Possible slight organic pollution
4.51 to 5.50	Some organic pollution
5.51 to 6.50	Fairly significant organic pollution
6.51 to 7.50	Significant organic pollution
7.51 to 8.50	Very significant organic pollution
8.51 to 10.00	Severe organic pollution

Benthic Index of Biotic Integrity – The Benthic Index of Biotic Integrity (B-IBI) (Kleindl 1995) is a relatively new multi-metric index used to assess the biotic integrity of streams. The B-IBI is a modified version of the IBI that was first developed to assess fish communities in midwestern streams (Karr 1991). The modification involves the use of aquatic macroinvertebrates rather than fish to assess the biological health of a stream in relation to human and ecosystem disturbances (Table 2).

The B-IBI incorporates a number of metrics or attributes of the macroinvertebrate community that change in predictable ways in response to human disturbance. The metrics used in the calculation of the B-IBI were consistent with the metrics used by Ecology in their calculation of biotic integrity and included: 1) total taxa richness, 2) Ephemeroptera taxa richness, 3) Plecoptera taxa richness, 4) Trichoptera taxa richness, 5) intolerant taxa richness, 6) long-lived species taxa richness, 7) percentage of tolerant taxa, 8) percentage of predators, and 9) percentage of Planaria and Amphipoda. Each metric in the B-IBI is given a score to reflect the level of disturbance that is detected by the metric (5 for minimal, 3 for moderate, and 1 for severe disturbance).

Table 2. Metrics and scoring criteria for each metric in the Puget Sound B-IBI. (Adapted from Kleindl 1995).

Metric	1 if ...	3 if ...	5 if ...
Taxa Richness	<10.0	10.0-20.0	>20.0
Ephemeroptera Richness	<3.0	3.0-5.5	>5.5
Plecoptera Richness	<3.0	3.0-6.0	>6.0
Trichoptera Richness	<2.0	2.0-4.5	>4.5
Intolerant Taxa Richness	<0.5	0.5-2.0	>2.0

Long-lived Taxa Richness	<0.5	0.5-2.0	>2.0
% Planaria and Amphipods Abundance	>20%	5%-20%	<5%
% Tolerant Taxa	>50%	20%-50%	<20%
% Predator Taxa	<15%	15%-30%	>30%

All metric scores are summed to calculate the total B-IBI value. B-IBI scores are as follows:

- 39 - 45 = excellent biological integrity;
- 32 - 38 = good biological integrity;
- 25 - 30 = fair biological integrity;
- 18 - 24 = poor biological integrity; and
- 09 - 18 = very poor biological integrity

Multi-metric indexes like the B-IBI are better at detecting disturbances than single metric indexes (e.g., presence or absence of indicator species) because they use a number of biological attributes that integrate information from ecosystem, community, population, and individual levels (Barbour et al. 1995).

4. RESULTS AND DISCUSSION

4.1 SALMONID SPAWNING

A total of 12 surveys were conducted from 22 August 2003 through 5 February 2004. Chinook, chum and coho salmon were the only species observed during these surveys. The results of individual index reaches and discussion are presented in their respective sections below. In addition, one snorkel survey was performed in the Project Area.

4.1.1 Lower Goldsborough Creek RM 0.5-2.2

During 2003 approximately 8,900 feet of stream in Goldsborough Creek were surveyed beginning at the bridge at 7th Street and proceeding upstream through the Project Area. This survey reach ends at the upstream-most weir just above the railroad bridge (Figures 6 and 7).

A total of 274 live and 37 dead chum were observed in Lower Goldsborough Creek (Table 3; Table A-1). The first chum was observed during the third week of surveys on 23 September 2003 (Figure 8). The number of live chum increased to a peak of 211 fish counted on 10 November 2003. The last live chum (n=2) was observed on 21 January 2004. One live Chinook was counted in this reach on 23 September 2003. Three live coho were observed on 10 November 2003. However, high streamflow hindered survey visibility during the end of November and beginning of December below the Project Area when coho were expected to be present.

4.1.2 Middle Goldsborough Creek RM 2.3-3.4

The 2003 survey effort covered approximately 5,280 feet of stream in Goldsborough Creek immediately upstream of the Project Area (Figures 9 and 10). 34 live chum and 6 live coho were observed in this survey reach (Table A-2). The first chum was seen on 10 October 2003 and the last on 22 December 2003. The coho were seen between 10 November and 22 December 2003. 13 chum redds and 1 coho redd were counted, but no carcasses for either species were observed. No Chinook were observed above the Project Area during surveys in 2003.

Table 3. Summary of live salmon counts for five index reaches established in the Goldsborough Creek basin, 1999-2003. Data from R2 Resource Consultants and WDFW (escapement estimates in parentheses when available).

	1999	2000	2001	2002	2003
Coffee Creek					
Chinook	0	0	0	0	0
Chum	31	20	291 (814)	188	60
Coho	0	33	2	1	6
Lower Goldsborough					
Chinook	2	22	10	7	1
Chum	119 (239)	174 (236)	71 (248)	278	274
Coho	0	96	2	4	3
Middle Goldsborough					
Chinook	0	0	1	0	0
Chum	0	0	35 (84)	28	34
Coho	0	5	4	2	6
Upper Goldsborough					
Chinook	0	0	0	0	0
Chum	0	0	0	0	3
Coho	0	0	0	0	2
S. Fork Goldsborough					
Chinook	0	0	0	0	0
Chum	0	0	0	0	0
Coho	0	0	10	0	0
Totals					
Chinook	2	22	11	7	1
Chum	150	194	397	494	371
Coho	0	134	18	7	17

4.1.3 Upper Goldsborough Creek RM 5.8-6.7

The 2003 survey effort covered approximately 5,280 feet of stream in Goldsborough Creek immediately upstream and downstream of the Matlock Road Bridge (near Carmen Road) (Figures 11 and 12). Three live chum and two live coho and two coho redds were observed in upper Goldsborough Creek (Table A-3). The coho redds were seen on 5 January 2004, slightly later than those observed in the lower reaches. These are the first active salmon redds (one unoccupied redd was seen in 2002) to be observed in this reach since the inception of the surveys in 1999.

4.1.4 South Fork Goldsborough Creek RM 9.9-11.0

Approximately one mile (5,280 feet) of South Fork Goldsborough Creek was surveyed during the 2003 survey effort (Figures 13 and 14). No adult salmon or redds were seen during any of the surveys in South Fork Goldsborough Creek (Table A-4). This is the second consecutive year that adult salmon were not seen in this reach (Table 3). Escapement

estimates for the South Fork Goldsborough Creek coho have recently been in decline (Figure 22).

4.1.5 Coffee Creek RM 0.0-0.3

The 2003 survey effort covered approximately 1,580 feet of stream in Coffee Creek (Figures 15 and 16). A total of 60 live chum and 6 live coho were observed in Coffee Creek (Table A-5; Figure 17). The first chum was seen on 10 October 2003, the majority of the fish (n=53) were counted the following survey on 27 October 2003. The coho were observed on 24 November (n=3) and 10 December 2003 (n=3). Thirty-seven chum and two coho redds were observed in Coffee Creek. The peak live and dead counts corresponded with a drop in temperature from 10.0°C to 6.0°C on 10 November 2003.

4.1.6 Snorkel Surveys

One snorkel survey was performed on 24 February 2004. The survey encompassed the South Fork Goldsborough Creek and the Project Area. The only salmonids observed were two mountain whitefish (*Prosopium williamsoni*) in the set of weirs below the upstream most set.

4.1.7 Temperature and Discharge Monitoring Results

Stage height at the stream gage near the Highway 101 bridge in Shelton was recorded during each spawning survey (Figure 18). This stream gage is maintained by the Squaxin Island Tribe. Discharge results from this gage are presented in Figure 19. An Onset Optic StowAway temperature monitor was installed on 21 August 2003 in the mainstem of Goldsborough Creek near the gage. Data are not yet available for this monitor but handheld thermometer readings taken in the same location ranged from a high of 14.0°C in August to a low of 6.0°C in January. Results from this monitor for the 2002 survey season are provided in Figure 20.

4.1.8 Summary

Total live salmon counts declined for the first year since surveys were begun in 1999. From 1994 through 1998, escapement to Goldsborough Creek through and downstream of the Project Area averaged 1,714 chum (std. deviation = 1,261) but recently has been in a period of decline (Figure 21; Table A-6).

The survey results from 2003 are similar in number to 2002 with the exception of the results from Coffee Creek. The number of fish entering Coffee Creek rose drastically in 2001, from 20 fish in 2000 to 291 fish. This was most likely due to construction activities taking place upstream. The following year the number dropped to 188, and this year, 2003, to 60. It appears the chum utilization of Coffee Creek has begun to return to pre-construction levels.

These results indicate that the removal of the dam may have affected the salmon population throughout the drainage, not just directly within the Project Area.

The results from three of the four previous survey years, indicate two peaks to the chum run in Goldsborough Creek, one in October/November and one in late December to January. However, the results from 2003 only define one peak, in late October/early November. Goldsborough Creek is identified by the WDFW (WDFW 1994) to contain primarily fall run fish, which spawn in early December to early February (Kuttel 2002). Summer chum that spawn from September to late October have also been identified in Goldsborough Creek (WDFW 1993).

This year, 2003, was the first observation of live chum and spawning coho in the uppermost survey reach of the mainstem Goldsborough Creek indicating that there is continued re-colonization of the habitat above the Project Area. Increased re-colonization may also allow for increasing numbers of fish to pass through and spawn above the survey zone without being counted. This may be particularly true for coho. However, chum salmon utilization is most likely still heaviest in the lower reaches of Goldsborough Creek.

Overall more coho (n=17) were counted this year than last year (n=7), but fewer Chinook (n=1 vs. n=7). However, these numbers are still relatively low, indicating escapement is in decline.



Figure 6. Upstream end of Lower Goldsborough Creek index reach located downstream of the Project Area (RM 0.5-2.2).



Figure 7. Downstream end of Lower Goldsborough Creek index reach located downstream of the Project Area (RM 0.5-2.2).

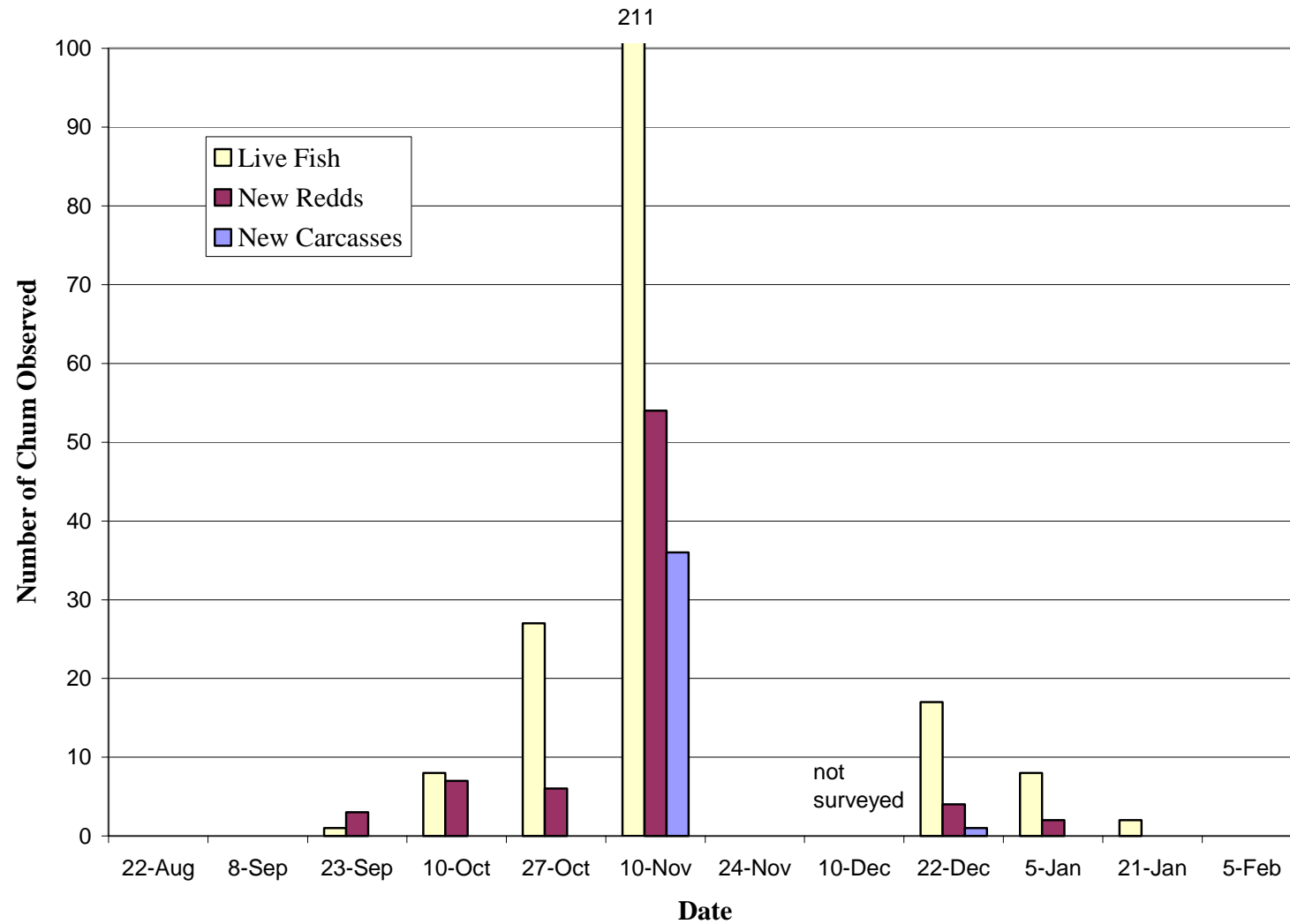


Figure 8. Number of live chum, chum carcasses, and new chum redds observed during spawning surveys conducted in Lower Goldsborough Creek index reach (RM 0.5-2.2), 2003.



Figure 9. Upstream end of Middle Goldsborough Creek index reach located upstream of Project Area (RM 2.4-3.4).



Figure 10. Downstream end of Middle Goldsborough Creek index reach located upstream from Project Area (RM 2.4-3.4).



Figure 11. Upstream end of Upper Goldsborough Creek index reach (RM 5.8-6.7).



Figure 12. Downstream end of Upper Goldsborough Creek index reach (RM 5.8-6.7).



Figure 13. Upstream end of South Fork Goldsborough Creek index reach (RM 9.9-11.0).



Figure 14. Downstream end of South Fork Goldsborough Creek index reach (RM 9.9-11.0).



Figure 15. Upstream end of Coffee Creek index reach (RM 0.0-0.3).



Figure 16. Downstream end of Coffee Creek index reach (RM 0.0-0.3).

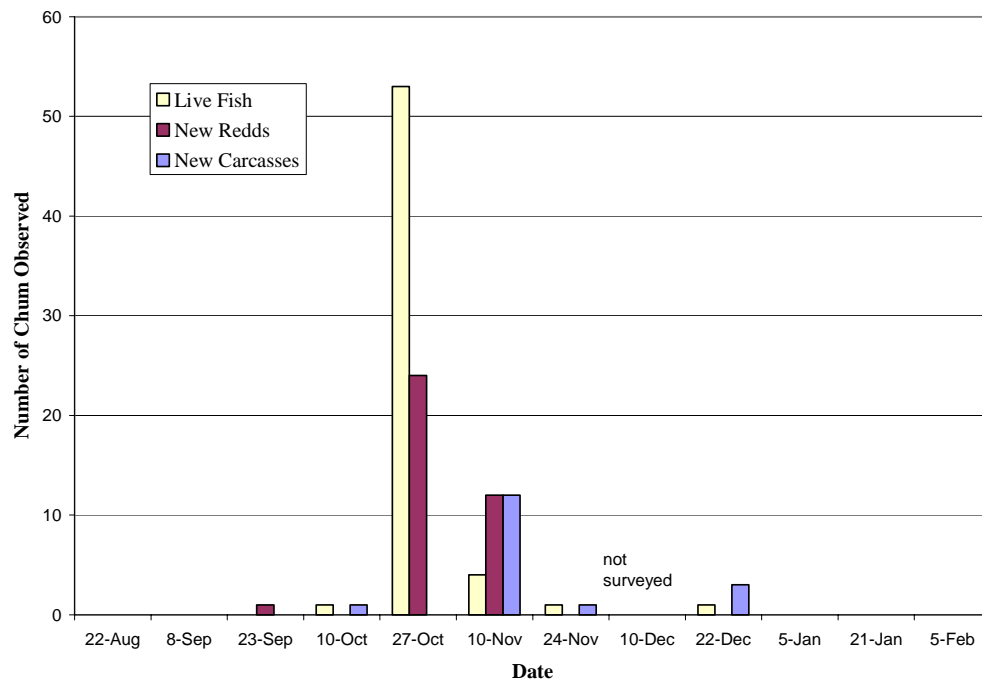


Figure 17. Number of live chum, chum carcasses, and new chum redds observed during spawning surveys conducted in Coffee Creek (RM 0.0-0.3), 2002.

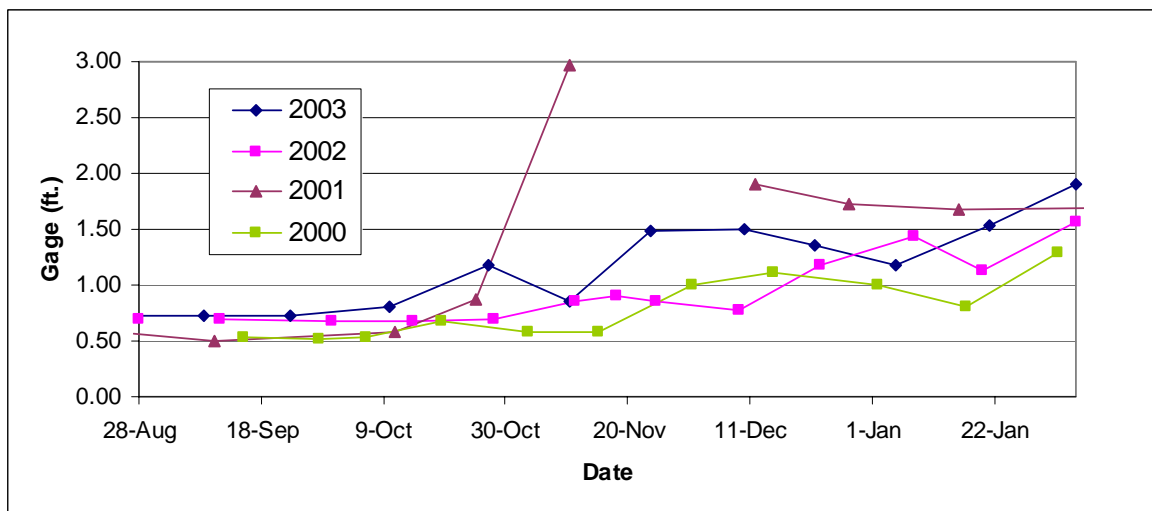


Figure 18. Stream gage height measurements for survey dates in Goldsborough Creek 2000-2003.

**Goldsborough Stream Discharge Hydrograph
May 2002 - June 2004**

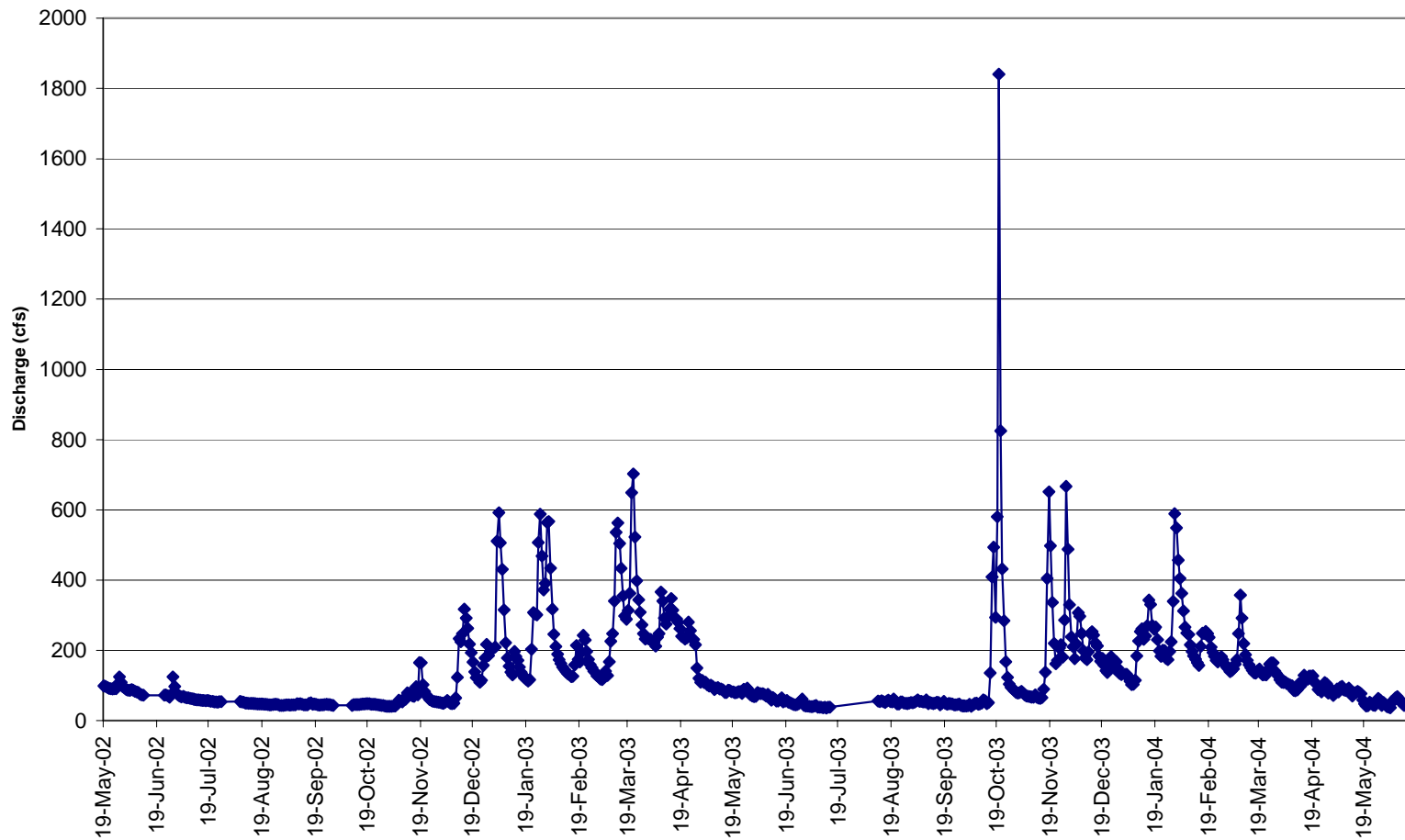


Figure 19. Goldsborough Creek discharge hydrograph provided courtesy of the Squaxin Island Tribe.

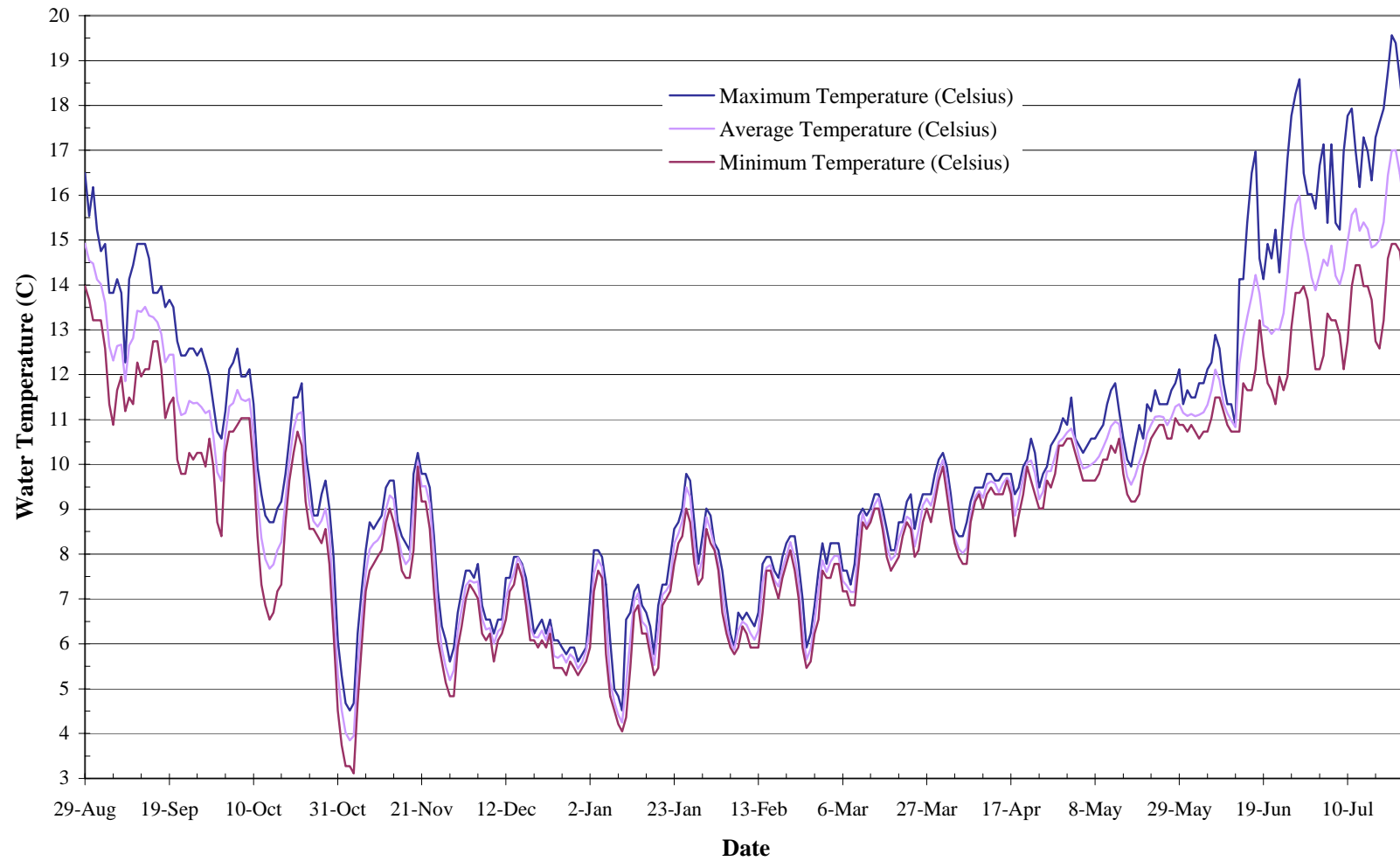


Figure 20. Minimum, average and maximum stream temperature in Goldsborough Creek, Washington, 2002-2003.

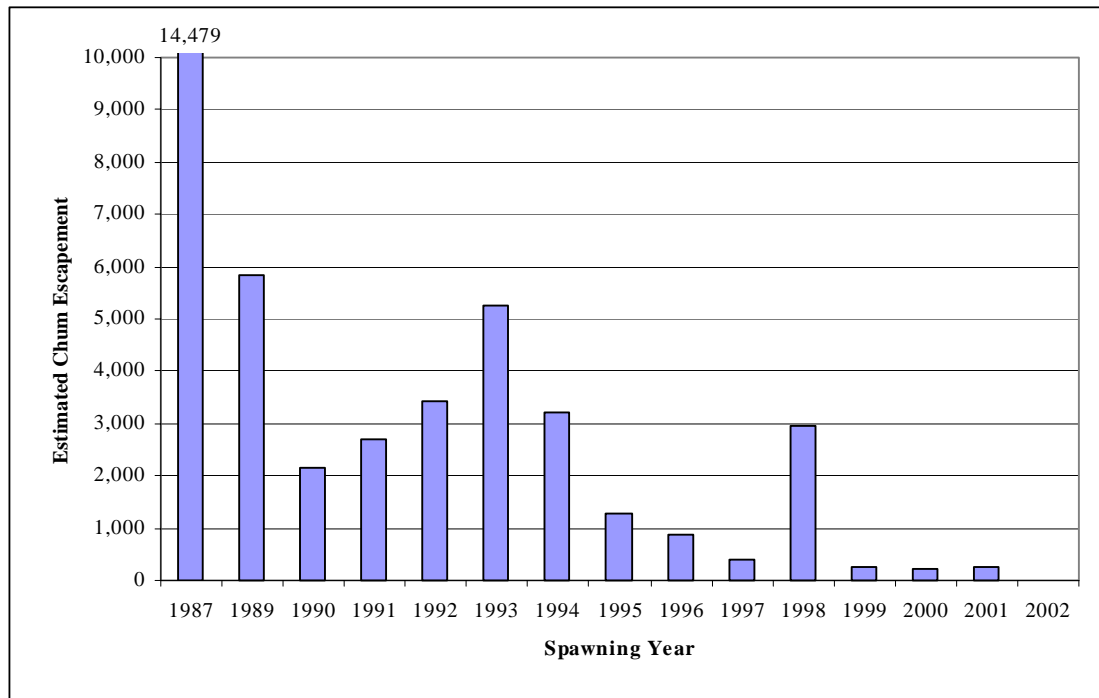


Figure 21. Estimated chum salmon escapement to Goldsborough Creek basin, Washington (RM 0.5-2.2), 1987-2002 (adapted from Seavey 1999).

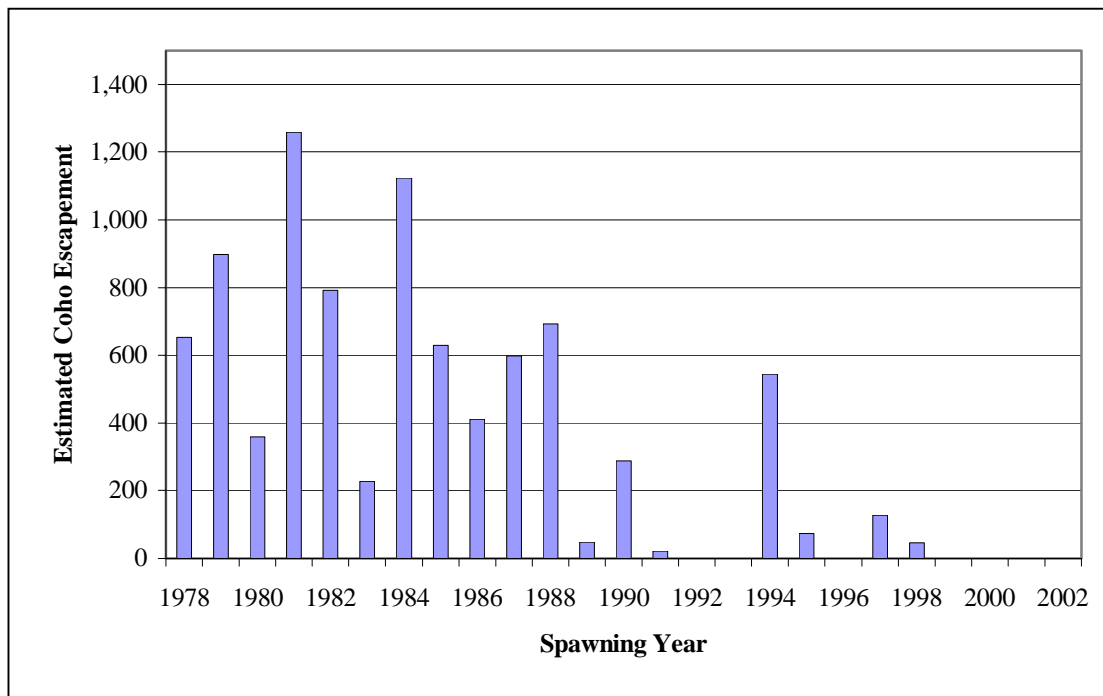


Figure 22. Estimated coho salmon escapement to the South Fork Goldsborough Creek, Washington (RM 9.9-11.0), 1978-2002 (adapted from Seavey 1999).

4.2 MACROINVERTEBRATE SURVEYS

The following macroinvertebrate data results are discussed primarily in terms of the metrics used to calculate the B-IBI score. These metrics are outlined in Table 2. See appendix B for complete macroinvertebrate sample analysis summary from Aquatic Biology Associates. Macroinvertebrates were collected at 4 sample sites. Site 1 is located below the weirs, site 2 is within the lowest weir set, site 4 is just upstream of the weirs, and site 5 is further upstream near the Carmen Rd. bridge. Site 3 (middle weirs) was discontinued in 2003-2004; due to its similarity to Site 2.

Density – Total macroinvertebrate abundance was generally higher for the February samples (average = 1,738 per m²) than the October samples (average = 1,241 per m²). The highest density was recorded at Site 5 in February, the lowest at Site 2 in October. High macroinvertebrate densities do not necessarily indicate a healthy stream. Conversely, high density coupled with low diversity could indicate disturbed conditions. Similarly, low macroinvertebrate densities have been measured in pristine habitats with excellent water quality. The macroinvertebrate densities for 2003-2004 were much lower than those reported in 2002-2003. This is particularly true for the October samples that had an average density of 18,140 per m² in 2002-2003. One contributing factor for the large difference between years may be the dry water year of 2002-2003. In addition, the 2002-2003 samples were taken before streamflow increased with fall rains. These two factors could have concentrated the invertebrates in the remaining wetted stream bottom, thus increasing densities. In contrast, the 2003-2004 samples while collected at a similar time of year, were collected after the first fall rains and subsequent increase in streamflow that may have dispersed and flushed invertebrate populations.

Taxa Richness – Taxa richness (number of unique invertebrate taxa) is generally considered to be one of the most useful metrics to describe biological integrity in streams. The total number of macroinvertebrate taxa in a stream reflects the diversity of the benthic community and is typically directly related to stream health. Taxa richness in Goldsborough Creek in October ranged from a low of 45 individual species to a high of 53 species. February diversity ranged from a low of 49 to a high of 62 species. For these samples, the total number of taxa (or species diversity) received a metric ranking of 5 (high) for all samples in both seasons (see Table 2 for a description of rankings). These results are similar to those found in 2002-2003. USFWS results from October 1998 indicate a rating of 5 for these sites as well (Missildine et al. 1999).

Mayfly, Stonefly, and Caddisfly (EPT) Taxa Richness – The number of mayfly (Ephemeroptera), stonefly (Plecoptera) and caddisfly (Trichoptera) (EPT) species present in a stream is typically positively correlated to the water quality and negatively to habitat disturbance. EPT taxa richness ranged from 23 to 28 species in October in Goldsborough Creek samples and from 22 to 27 species in the February samples. Again, these results are similar for the sites that were sampled in 2002-2003. Taxa richness for each of the three individual orders were all relatively high and were ranked at 5 with the exception of one

sample (February Site 5) where the Plecoptera taxa richness was ranked 3. In particular, the fall sample for site 4 (just above the project area) increased from 20 total EPT in 2002-2003 to 28 in 2003-2004.

Intolerant Taxa Richness – Intolerant taxa are those most sensitive to water quality degradation or habitat disturbances. The presence of intolerant taxa indicates good water quality and natural, undisturbed habitat. Total intolerant taxa richness for the October samples ranged from 3 to 4 species. February samples ranged from 2 to 5 species. All samples received a ranking of 5 except sites 1 and 2 in February, which ranked 3. Sites 1 and 2, the downstream-most sites, have the greatest potential for impacts such as sediment movement, from the weir project. Intolerant taxa richness increased slightly for the October samples and decreased slightly for February in comparison to corresponding sites sampled in 2002-2003.

Long-Lived Taxa Richness – The presence of long-lived taxa indicates a relatively stable environment that allows for the presence of species that require more than one year to complete their lifecycles. The number of long-lived taxa ranged from 3 to 6 species in the October samples and from 4 to 7 species in February. The metric rank for all the samples is 5 (high). This is a slight increase in the totals over the 2002-2003 samples. As stability returns to the Project Area more long-lived taxa are expected to occur.

Percent Planaria and Amphipoda – No Planaria or Amphipoda species were found in any of the samples except for a small percentage (0.32) for Site 5 in October. The lack of these species indicates good water quality conditions and ranks 5 on the B-IBI metric scoring table (see Table 2). No Planaria or Amphipoda species were found during the 2002-2003 samples.

Percent Tolerant Taxa – Percent tolerant taxa ranged from 3.5 to 36.8% for the October samples, and 10.1 to 23.3 for the February samples. In both sampling periods, Site 5 had the highest percentage of tolerant taxa. All sites ranked 5, high, with the exception of Site 5, which ranked 3 (moderate). The samples taken in sites 1 and 2 (within and downstream of the project area) showed a marked decrease in tolerant taxa percentage over the 2002-2003 samples. The USFWS data from pre-dam construction rated all sites 5, or high (Missildine et al. 1999). The results of this metric may indicate that the disturbed habitat of the weir sites may be returning to pre-construction conditions.

Percent Predator Taxa – All sampled sites had a low percent of predator species in comparison to other Puget Sound lowland streams. October samples ranged from 5.2 to 8.3%. February samples ranged from 2.6 to 10.9%. Any total less than 15% scores low (1) on the metric ranking scale (see Table 2). These results are similar to those found in the 2002-2003 samples. USFWS 1998 samples ranked 3, or moderate, on the B-IBI metric scale.

Functional Feeding Group Classification – The dominant functional feeding group (measured by percent abundance) changed from collector/gathers and collector/filterers in 2002-2003 to scrapers in 2003-2004. However, while there are more individual scrapers by

percent in 2003, there is a greater diversity of collector/gatherer taxa species. Scrapers feed on periphyton-attached algae and associated material. Most scraper species are also clingers (grasp hard bottom surfaces in fast currents). It could be possible that the higher flows during and before the 2003 surveys washed out a large number of the other feeding group individuals.

Modified Hilsenhoff Biotic Index – Modified Hilsenhoff Biotic Index scores for all sites in both sampling seasons were below 4.5 with the exception of Site 5. A ranking below 4.5 corresponds to “no apparent organic pollution,” or “possible slight organic pollution.” Site 5 for both seasons rated between 4.5 and 5.5 or “some organic pollution.”

Benthic Index of Biotic Integrity – The B-IBI scores ranged from 39 to 41 for the October samples and from 7 to 41 for the February samples (Table 4). The scores for the October samples are within the range that is considered “excellent” for the index (see section 3.4). The February scores are also “excellent” with the exception of Site 5, which is “good.” In general these scores are slightly higher than those for samples collected in 2002-2003.

Table 4. B-IBI scores and ranking for four Goldsborough Creek sample sites (see Appendix Tables for complete B-IBI information).

	R2 Site 1 / USFWS Site 1	R2 Site 2 / No USFWS	R2 Site 3 / USFWS Site 2	R2 Site 4 / USFWS Site 3	R2 Site 5 / USFWS Site 4
1998 fall	35 (good)	-	29 (fair)	29 (fair)	37 (good)
1998 fall (adjusted)	39 (excellent)	-	33 (good)	33 (good)	41 (excellent)
2002 fall	35 (good)	35 (good)	35 (good)	37 (good)	-
2002 winter	41 (excellent)	39 (excellent)	41 (excellent)	41 (excellent)	-
2003 fall	41 (excellent)	41 (excellent)	-	41 (excellent)	39 (excellent)
2003 winter	39 (excellent)	39 (excellent)	-	41 (excellent)	37 (good)

Conclusions –While overall macroinvertebrate density was much less in 2003 for the October samples, diversity and B-IBI scores were greater in comparison to 2002 results. This may be a reflection of sampling timing verses streamflow, drought or other environmental conditions and should not be automatically considered a drastic decline in macroinvertebrate populations. Macroinvertebrate samples are better analyzed looking at the broad picture, using all the metrics available, and not focusing on density alone. Furthermore, additional sampling years will provide valuable data for comparison. The results from February 2003 were similar with the previous survey year (2002).

R2 Site 5, the upstream most site, was not an ideal candidate for macroinvertebrate sampling using the protocol outlined by Plotnikoff (1994). The substrates present at this site were

coarser and the stream flows generally faster than is recommended for this protocol. This may have been reflected in the slightly poorer rankings this site received.

Benthic macroinvertebrates are an indicator of a stream's overall biological condition, and its ability to support salmonid populations. High B-IBI scores, as obtained from four sites, are indicative of good water quality and benthic invertebrate habitat conditions in the study reach of Goldsborough Creek and therefore healthy salmonid habitat.

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APPENDIX A

Raw Data

Biological Monitoring Goldsborough Creek, Washington 2003 Spawning and Macroinvertebrate Surveys Data Report

Table A-1. Date, species, number of live and dead salmon, and number of new redds observed, water temperature (°C), and stage observed in Lower Goldsborough Creek, Washington, (RM 0.5-2.2), 2003.

Date	Species	Live	Dead	Redds	Water Temp. (°C)	Stage (ft)
22-Aug-03	chum	0	0	0	14.0	0.40
8-Sep-03	Chinook	0	0	1	13.0	0.40
8-Sep-03	chum	0	0	0	14.0	0.37
23-Sep-03	chum	1	0	3	12.0	0.49
23-Sep-03	Chinook	1	0	1	12.0	0.87
10-Oct-03	chum	8	0	7	11.0	0.53
27-Oct-03	chum	27	0	6	10.0	1.25
10-Nov-03	chum	211	36	54	8.5	1.29
10-Nov-03	coho	3	0	0	8.5	1.06
22-Dec-03	chum	17	1	4	7.5	0.87
5-Jan-04	chum	8	0	2	6.0	1.33
21-Jan-04	chum	2	0	0	7.0	1.60
5-Feb-04	chum	0	0	0	n/a	0.40
Totals		278	37	78		

Table A-2. Date, species, number of live and dead salmon, and number of new redds, water temperature (°C) observed in Middle Goldsborough Creek, Washington, upstream of the Project Area (RM 2.3-3.4), 2003.

Date	Species	Live	Dead	Redds	Water Temp. (°C)
22-Aug-03	chum	0	0	0	14.0
8-Sep-03	chum	1	0	3	14.0
10-Oct-03	chum	5	0	1	n/a
27-Oct-03	chum	21	0	8	10.0
10-Nov-03	chum	7	0	1	8.5
10-Nov-03	coho	4	0	1	8.5
10-Dec-03	coho	1	0	0	8.0
22-Dec-03	coho	1	0	0	7.5
5-Jan-04	chum	0	0	0	6.0
21-Jan-04	chum	0	0	0	8.0
5-Feb-04	chum	0	0	0	n/a
<i>Totals</i>		<i>40</i>	<i>0</i>	<i>14</i>	

Table A-3. Date, species, water temperature (°C), number of live and dead salmon, and number of new redds observed in Upper Goldsborough Creek, Washington (RM 5.8-6.7), 2003.

Date	Species	Live	Dead	Redds	Water Temp. (°C)
22-Aug-03	all	0	0	0	14.0
8-Sep-03	all	0	0	0	14.0
23-Sep-03	all	0	0	0	12.0
10-Oct-03	chum	3	0	0	10.5
27-Oct-03	all	0	0	0	9.0
10-Nov-03	all	0	0	0	7.5
24-Nov-03	coho	1	0	0	6.0
24-Nov-03	all	0	0	0	6.0
22-Dec-03	all	0	0	0	n/a
5-Jan-04	coho	1	0	2	6.0
21-Jan-04	all	0	0	0	7.0
Totals		5	0	2	

Table A-4. Date, species, water temperature (°C), number of live and dead salmon, and number of new redds observed in the South Fork Goldsborough Creek, Washington (RM 9.9-11.0), 2003.

Date	Species	Live	Dead	Redds	Water Temp.(°C)
8-Sep-03	all	0	0	0	13.0
23-Sep-03	all	0	0	0	11.5
10-Oct-03	all	0	0	0	12.0
27-Oct-03	all	0	0	0	10.0
10-Nov-03	all	0	0	0	7.5
24-Nov-03	all	0	0	0	7.0
10-Dec-03	all	0	0	0	7.5
5-Jan-04	all	0	0	0	n/a
21-Jan-04	all	0	0	0	7.5
5-Feb-04	all	0	0	0	5.5
<i>Totals</i>		<i>0</i>	<i>0</i>	<i>0</i>	

Table A-5. Date, species, water temperature (°C), number of live and dead salmon, and number of new redds observed in Coffee Creek, Washington (RM 0.0-0.3), 2003.

Date	Species	Live	Dead	Redds	Water Temp.(°C)
22-Aug-03	chum	0	0	0	14.0
8-Sep-03	chum	0	0	0	12.5
23-Sep-03	chum	0	0	1	11.5
10-Oct-03	chum	1	1	0	13.0
27-Oct-03	chum	53	0	24	10.0
10-Nov-03	chum	4	12	12	6.0
24-Nov-03	chum	1	1	0	5.0
24-Nov-03	coho	3	0	1	5.0
10-Dec-03	coho	3	0	1	7.0
22-Dec-03	chum	1	3	0	n/a
5-Jan-04	chum	0	0	0	n/a
21-Jan-04	chum	0	0	0	6.0
5-Feb-04	chum	0	0	0	5.0
<i>Totals</i>		<i>66</i>	<i>17</i>	<i>39</i>	

Table A-6. Estimated coho and chum salmon escapement in two reaches of Goldsborough Creek, Washington, 1978-2003.

Year	Estimated Escapement		
	Coho RM 9.9-11.0 ¹	Chum RM 0.5-2.2 ²	Chum RM 2.3 –3.4
1978	653	-	-
1979	898	-	-
1980	360	-	-
1981	1,259	-	-
1982	792	-	-
1983	228	-	-
1984	1,123	-	-
1985	630	-	-
1986	411	-	-
1987	598	14,479	-
1988	694	-	-
1989	48	5,843	-
1990	287	2,166	-
1991	22	2,687	-
1992	0	3,428	-
1993	0	5,250	-
1994	544	3,199	-
1995	74	1,283	-
1996	0	888	-
1997	128	405	-
1998	47	2,969	-
1999	0	239	0
2000	0	236	0
2001	0	248	84
2002	0	n/a	n/a
2003	0	n/a	n/a

¹ Zero indicates that no coho were observed in study section during that spawning year.

² Dash lines indicate that the study section was not surveyed during that spawning year.



APPENDIX B

Macroinvertebrate Data

Biological Monitoring
Goldsborough Creek, Washington
2003 Spawning and
Macroinvertebrate Surveys
Data Report

Benthic Invertebrate Index of Biological Integrity-BIBI (Kleindl 1995)

For R2 Resource Consultants, Inc., Redmond, Washington, by Aquatic Biology Associates, Inc., Corvallis, Oregon.

WA Department of Ecology sampling protocol, D-frame net, riffle, 4 point composite, 8 square feet, 500 micron mesh.

Aquatic Biology Associates, Inc. standard taxonomic effort (level 3).

Average densities adjusted to a square meter basis. Kleindl (1995) BIBI for Puget Lowland streams.

Station	Goldsborough Creek Site 1		Goldsborough Creek Site 2		Goldsborough Creek Site 4		Goldsborough Creek Site 5	
Date	10/27/03		10/27/03		10/27/03		10/27/03	
	below weir		lower weirs		above weirs		Carmen Rd. bridge	
METRIC	Value	Score	Value	Score	Value	Score	Value	Score
D Total number of taxa	45	5	45	5	47	5	53	5
D Number Ephemeroptera taxa	7	5	8	5	9	5	9	5
D Number Plecoptera taxa	7	5	11	5	9	5	9	5
D Number Trichoptera taxa	9	5	8	5	10	5	10	5
D Number of intolerant taxa	3	5	4	5	4	5	4	5
D Number of long-lived taxa	3	5	3	5	5	5	6	5
I %Planaria & Amphipoda	0	5	0	5	0	5	0.32	5
I % Tolerant taxa	7.48	5	9.54	5	3.53	5	36.82	3
D % Predator	6.75	1	8.33	1	5.18	1	7.81	1
TOTAL SCORE		41		41		41		39
BIOLOGICAL CONDITION CATEGORY								

Maximum score of 45.

Each metric scored: 1=low, 3=moderate, 5=high

OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION

Total abundance (m2)	937	891	1983	1153
D EPT taxa richness	23	27	28	28
D Predator richness	14	14	14	16
D Scraper richness	16	14	15	18
D Shredder richness	2	6	6	5
D %Intolerant taxa	2.44	4.09	4.35	1.72
I Community tolerance (MHBI)	3.98	3.98	3.29	4.53
I % 3 dominant taxa	64.26	61.21	65.54	53.11
I %Collector	36.29	38.47	27.69	21.61
I %Parasite	3.6	1.97	0.95	1.09
I %Oligochaeta	1.15	4.39	0.14	7.3
I Number tolerant taxa	9	7	5	9
I %Simuliidae	0.14	0.15	0.81	6.37
I %Chironomidae	9.51	9.55	3.66	1.4

L,M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

I= Metric value generally increases with declining biological integrity.

D= Metric value generally decreases with declining biological integrity.

	Total score
VP= very poor biological integrity	9-18
P= poor biological integrity	18-24
F= fair biological integrity.	25-31
G= good biological integrity	32-38
E= excellent biological integrity.	39-45

Benthic Invertebrate Index of Biological Integrity-BIBI (Kleindl 1995)

For R2 Resource Consultants, Inc., Redmond, Washington, by Aquatic Biology Associates, Inc., Corvallis, Oregon.

WA Department of Ecology sampling protocol, D-frame net, riffle, 4 point composite, 8 square feet, 500 micron mesh.

Aquatic Biology Associates, Inc. standard taxonomic effort (level 3).

Average densities adjusted to a square meter basis. Kleindl (1995) BIBI for Puget Lowland streams.

Station	Goldsborough Creek Site 1		Goldsborough Creek Site 2		Goldsborough Creek Site 4		Goldsborough Creek Site 5	
Date	2/24/04		2/24/04		2/24/04		2/24/04	
	below weir		lower weirs		above weirs		Carmen Rd. bridge	
METRIC	Value	Score	Value	Score	Value	Score	Value	Score
D Total number of taxa	55	5	49	5	62	5	52	5
D Number Ephemeroptera taxa	11	5	9	5	10	5	8	5
D Number Plecoptera taxa	11	5	7	5	8	5	4	3
D Number Trichoptera taxa	7	5	8	5	9	5	10	5
D Number of intolerant taxa	2	3	2	3	5	5	3	5
D Number of long-lived taxa	5	5	4	5	4	5	7	5
I %Planaria & Amphipoda	0	5	0	5	0	5	0	5
I % Tolerant taxa	10.23	5	10.13	5	11.54	5	23.29	3
D % Predator	6.1	1	4.23	1	10.85	1	2.57	1
TOTAL SCORE		39		39		41		37
BIOLOGICAL CONDITION CATEGORY								

Maximum score of 45.

Each metric scored: 1=low, 3=moderate, 5=high

OTHER COMMUNITY COMPOSITION METRICS THAT ARE INDICATIVE OF BIOLOGICAL CONDITION

Total abundance (m2)	1015	1727	1289	2921
D EPT taxa richness	29	24	27	22
D Predator richness	13	13	15	7
D Scraper richness	18	16	19	18
D Shredder richness	6	4	5	5
D %Intolerant taxa	0.26	0.63	1.25	0.98
I Community tolerance (MHBI)	3.81	4.1	4.08	5.14
I % 3 dominant taxa	53.59	42.84	47.78	64.09
I %Collector	24.99	38	33.21	69.85
I %Parasite	0.79	0.62	0.42	1.35
I %Oligochaeta	0.53	0.93	0.28	1.1
I Number tolerant taxa	5	5	5	7
I %Simuliidae	3.06	11.68	4.86	51.1
I %Chironomidae	7.58	10.59	11.94	3.31

L,M & H comparisons with a Pacific Northwest montane stream with high biological integrity.

I= Metric value generally increases with declining biological integrity.

D= Metric value generally decreases with declining biological integrity.

	Total score
VP= very poor biological integrity	9-18
P= poor biological integrity	18-24
F= fair biological integrity.	25-31
G= good biological integrity	32-38
E= excellent biological integrity.	39-45

Goldsborough Creek, Site 1, below weirs, October 27, 2003

WA: Mason County, near Shelton, for R2 Resource Consultants, by ABA, Inc.

Benthic invertebrates, erosional habitat, D-frame net, 4 point, 8 ft², 500 micron.

Abundances converted to a square meter basis. FILE: 03FR201

IDENTIFICATION CODE	03FR2
CORRECTION FACTOR	1.35

Taxon	Abundance	%
Oligochaeta	11	1.15
<i>Pisidium</i>	1	0.14
<i>Physa/Physella</i>	1	0.14
<i>Juga</i>	3	0.29
Acari	34	3.60
TOTAL: NON INSECTS	50	5.33
<i>Baetis tricaudatus</i>	43	4.61
<i>Attenella delantala</i>	15	1.59
<i>Drunella doddsi</i>	14	1.44
<i>Ephemerella inermis</i>	5	0.58
<i>Epeorus</i>	12	1.30
<i>Rhithrogena</i>	394	42.07
<i>Paraleptophlebia</i>	1	0.14
TOTAL: EPHEMEROPTERA	485	51.73
Chloroperlidae	1	0.14
<i>Sweltsa</i>	8	0.86
<i>Zapada cinctipes</i>	18	1.87
<i>Hesperoperla pacifica</i>	3	0.29
<i>Cultus</i>	8	0.86
<i>Isoperla</i>	3	0.29
<i>Skwala</i>	14	1.44
TOTAL: PLECOPTERA	54	5.76
<i>Brachycentrus americanus</i>	4	0.43
<i>Micrasema</i>	1	0.14
<i>Glossosoma</i>	27	2.88
<i>Hydropsyche</i>	128	13.69
<i>Hydroptila</i>	1	0.14
<i>Rhyacophila Betteni</i> Group	7	0.72
<i>Rhyacophila Brunnea/Vemna</i> Group	1	0.14
<i>Rhyacophila narvae</i>	9	1.01
<i>Rhyacophila pellisa/valuma</i>	3	0.29
TOTAL: TRICHOPTERA	182	19.45

Goldsborough Creek, Site 1, below weirs, Oct. 27, 2003, con't.

IDENTIFICATION CODE	03FR2
CORRECTION FACTOR	1.35

Taxon	Abundance	%
Dytiscidae	1	0.14
<i>Cleptelmis addenda</i>	3	0.29
<i>Heterlimnius</i>	18	1.87
<i>Narpus</i>	1	0.14
<i>Optioservus</i>	14	1.44
<i>Zaitzevia</i>	3	0.29
TOTAL: COLEOPTERA	39	4.18
<i>Chelifera/Metachela</i>	1	0.14
<i>Glutops</i>	1	0.14
<i>Simulium</i>	1	0.14
<i>Antocha</i>	31	3.31
<i>Cryptolabis</i>	3	0.29
TOTAL: DIPTERA	38	4.03
<i>Cladotanytarsus</i>	80	8.50
<i>Heleniella</i>	1	0.14
<i>Lopescladius</i>	1	0.14
<i>Polypedilum</i>	1	0.14
<i>Rheotanytarsus</i>	3	0.29
<i>Thienemannimyia</i> Complex	3	0.29
TOTAL: CHIRONOMIDAE	89	9.51
GRAND TOTAL	937	100.00

Goldsborough Creek, Site 1, below weir, February 24, 2004

WA: Mason County, near Shelton, for R2 Resource Consultants, by ABA, Inc.

Benthic invertebrates, erosional habitat, D-frame net, 4 point, 8 ft², 500 u.

Abundances converted to a square meter basis. FILE: 04SR202

IDENTIFICATION CODE	04SR202
CORRECTION FACTOR	1.35

Taxon	Abundance	%
Nematoda	1	0.13
Oligochaeta	5	0.53
<i>Juga</i>	7	0.66
Acari	7	0.66
TOTAL: NON INSECTS	20	1.99
<i>Ameletus</i>	1	0.13
<i>Baetis tricaudatus</i>	85	8.38
<i>Diphetor hageni</i>	1	0.13
<i>Attenella delantala</i>	26	2.53
<i>Drunella coloradensis/flavilinea</i>	9	0.93
<i>Drunella doddsi</i>	1	0.13
<i>Ephemerella inermis</i>	3	0.27
<i>Cinygmula</i>	174	17.15
<i>Epeorus</i>	18	1.73
<i>Epeorus longimanus</i>	24	2.39
<i>Rhithrogena</i>	140	13.83
TOTAL: EPHEMEROPTERA	483	47.61
Capniidae	8	0.80
Chloroperlidae	4	0.40
<i>Paraperla</i>	1	0.13
<i>Sweltsa</i>	22	2.13
<i>Zapada cinctipes</i>	1	0.13
<i>Calineuria californica</i>	7	0.66
<i>Hesperoperla pacifica</i>	1	0.13
<i>Isoperla</i>	5	0.53
<i>Skwala</i>	1	0.13
<i>Pteronarcys californica</i>	1	0.13
<i>Taenionema</i>	24	2.39
TOTAL: PLECOPTERA	77	7.58
<i>Glossosoma</i>	5	0.53
<i>Hydropsyche</i>	24	2.39
<i>Dicosmoecus gilvipes</i>	9	0.93

Goldsborough Creek, Site 1, below weir, Feb. 24, 2004, con't.

IDENTIFICATION CODE	04SR202
CORRECTION FACTOR	1.35

Taxon	Abundance	%
<i>Rhyacophila Brunnea/Vemna Group</i>	1	0.13
<i>Rhyacophila narvae</i>	7	0.66
<i>Rhyacophila pellisa/valuma</i>	3	0.27
<i>Neophylax</i>	230	22.61
TOTAL: TRICHOPTERA	279	27.53
Dytiscidae	1	0.13
<i>Heterlimnius</i>	19	1.86
<i>Optioservus</i>	5	0.53
<i>Zaitzevia</i>	5	0.53
TOTAL: COLEOPTERA	31	3.06
::		
Ceratopogoninae	5	0.53
<i>Chelifera/Metachela</i>	3	0.27
<i>Prosimulium</i>	1	0.13
<i>Simulium</i>	30	2.93
<i>Antocha</i>	1	0.13
<i>Cryptolabis</i>	7	0.66
TOTAL: DIPTERA	47	4.65
Chironomidae-pupae	3	0.27
<i>Brillia</i>	1	0.13
<i>Cladotanytarsus</i>	27	2.66
<i>Eukiefferiella</i>	5	0.53
<i>Heleniella</i>	1	0.13
<i>Lopescladius</i>	1	0.13
<i>Micropsectra</i>	3	0.27
<i>Orthocladius</i>	24	2.39
<i>Parametriocnemus</i>	4	0.40
<i>Polypedilum</i>	1	0.13
<i>Thienemanniella</i>	1	0.13
<i>Tvetenia Bavarica Group</i>	4	0.40
TOTAL: CHIRONOMIDAE	77	7.58
GRAND TOTAL	1015	100.00

Goldsborough Creek, Site 2, lower weirs, October 27, 2003

WA: Mason County, near Shelton, for R2 Resource Consultants, by ABA, Inc.

Benthic invertebrates, erosional habitat, D-frame net, 4 point, 8 ft², 500 u.

Abundances converted to a square meter basis. FILE: 03FR203

IDENTIFICATION CODE	03FR203
CORRECTION FACTOR	1.35

Taxon	Abundance	%
Oligochaeta	39	4.39
<i>Pisidium</i>	1	0.15
<i>Juga</i>	8	0.91
Acari	18	1.97
TOTAL: NON INSECTS	66	7.42
<i>Baetis tricaudatus</i>	59	6.67
<i>Attenella delantala</i>	12	1.36
<i>Drunella doddsi</i>	28	3.18
<i>Ephemerella inermis</i>	4	0.45
<i>Cinygmula</i>	1	0.15
<i>Epeorus</i>	8	0.91
<i>Ironodes</i>	3	0.30
<i>Rhithrogena</i>	369	41.36
TOTAL: EPHEMEROPTERA	485	54.39
Chloroperlidae	3	0.30
<i>Sweltsa</i>	18	1.97
Leuctridae	1	0.15
<i>Zapada cinctipes</i>	12	1.36
<i>Zapada Oregonensis Group</i>	1	0.15
<i>Calineuria californica</i>	1	0.15
<i>Hesperoperla pacifica</i>	3	0.30
<i>Cultus</i>	5	0.61
<i>Isoperla</i>	8	0.91
<i>Skwala</i>	3	0.30
Taeniopterygidae	1	0.15
TOTAL: PLECOPTERA	57	6.36
<i>Micrasema</i>	1	0.15
<i>Glossosoma</i>	11	1.21
<i>Hydropsyche</i>	97	10.91
<i>Hydroptila</i>	1	0.15
<i>Onocosmoecus unicolor</i>	1	0.15
<i>Rhyacophila Betteni Group</i>	5	0.61

Goldsborough Creek, Site 2, lower weirs, Oct. 27, 2003, con't.

IDENTIFICATION CODE	03FR203
CORRECTION FACTOR	1.35

Taxon	Abundance	%
<i>Rhyacophila narvae</i>	14	1.52
<i>Rhyacophila pellisa/valuma</i>	7	0.76
TOTAL: TRICHOPTERA	138	15.45
<i>Cleptelmis addenda</i>	1	0.15
<i>Heterlimnius</i>	15	1.67
<i>Optioservus</i>	12	1.36
TOTAL: COLEOPTERA	28	3.18
<i>Chelifera/Metachela</i>	4	0.45
<i>Glutops</i>	1	0.15
<i>Simulium</i>	1	0.15
<i>Antocha</i>	16	1.82
<i>Cryptolabis</i>	8	0.91
<i>Hexatoma</i>	1	0.15
TOTAL: DIPTERA	32	3.64
<i>Cladotanytarsus</i>	80	8.94
<i>Demicryptochironomus</i>	1	0.15
<i>Paraphaenocladus</i>	1	0.15
<i>Polypedilum</i>	1	0.15
<i>Thienemannimyia</i> Complex	1	0.15
TOTAL: CHIRONOMIDAE	85	9.55
GRAND TOTAL	891	100.00

Goldsborough Creek, Site 2, February 24, 2004

WA: Mason County, near Shelton, for R2 Resource Consultants, by ABA, Inc.

Benthic invertebrates, erosional habitat, D-frame net, 4 point, 8 ft², 500 u.

Abundances converted to a square meter basis. FILE: 04SR204

IDENTIFICATION CODE	04SR204
CORRECTION FACTOR	2.69

Taxon	Abundance	%
Nematoda	5	0.31
Oligochaeta	16	0.93
<i>Juga</i>	11	0.62
Acari	5	0.31
TOTAL: NON INSECTS	38	2.18
<i>Baetis tricaudatus</i>	145	8.41
<i>Attenella delantala</i>	62	3.58
<i>Drunella coloradensis/flavilinea</i>	13	0.78
<i>Drunella doddsi</i>	3	0.16
<i>Ephemerella inermis</i>	16	0.93
<i>Cinygmula</i>	199	11.53
<i>Epeorus</i>	27	1.56
<i>Epeorus longimanus</i>	38	2.18
<i>Rhithrogena</i>	196	11.37
TOTAL: EPHEMEROPTERA	699	40.50
Chloroperlidae	5	0.31
<i>Sweltsa</i>	8	0.47
<i>Calineuria californica</i>	3	0.16
<i>Hesperoperla pacifica</i>	11	0.62
<i>Isoperla</i>	3	0.16
<i>Pteronarcys californica</i>	3	0.16
<i>Taenionema</i>	73	4.21
TOTAL: PLECOPTERA	105	6.07
<i>Brachycentrus americanus</i>	5	0.31
<i>Glossosoma</i>	3	0.16
<i>Hydropsyche</i>	43	2.49
<i>Dicosmoecus gilvipes</i>	13	0.78
<i>Rhyacophila Betteni Group</i>	3	0.16
<i>Rhyacophila narvae</i>	5	0.31
<i>Rhyacophila pellisa/valuma</i>	3	0.16
<i>Neophylax</i>	344	19.94
TOTAL: TRICHOPTERA	420	24.30

Goldsborough Creek, Site 2, Feb. 24, 2004, con't.

IDENTIFICATION CODE	04SR204
CORRECTION FACTOR	2.69

Taxon	Abundance	%
<i>Heterlimnius</i>	24	1.40
<i>Optioservus</i>	13	0.78
TOTAL: COLEOPTERA	38	2.18
Ceratopogoninae	8	0.47
Dolichopodidae	3	0.16
<i>Chelifera/Metachela</i>	11	0.62
<i>Glutops</i>	8	0.47
<i>Prosimulium</i>	8	0.47
<i>Simulium</i>	194	11.21
<i>Antocha</i>	8	0.47
<i>Cryptolabis</i>	3	0.16
<i>Hexatoma</i>	3	0.16
TOTAL: DIPTERA	245	14.17
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Chironomidae-pupae	3	0.16
<i>Brillia</i>	5	0.31
<i>Cladotanytarsus</i>	11	0.62
<i>Eukiefferiella</i>	16	0.93
<i>Eukiefferiella Devonica Group</i>	3	0.16
<i>Heleniella</i>	5	0.31
<i>Orthocladius</i>	132	7.63
<i>Parametriocnemus</i>	3	0.16
<i>Paraphaenocladius</i>	3	0.16
<i>Polypedilum</i>	3	0.16
TOTAL: CHIRONOMIDAE	183	10.59
GRAND TOTAL	1727	100.00

Goldsborough Creek, Site 4, above weirs, October 27, 2003

WA: Mason County, near Shelton, for R2 Resource Consultants, by ABA, Inc.

Benthic invertebrates, erosional habitat, D-frame net, 4 point, 8 ft², 500 u.

Abundances converted to a square meter basis. FILE: 03FR205

IDENTIFICATION CODE	03FR205
CORRECTION FACTOR	2.69

Taxon	Abundance	%
Oligochaeta	3	0.14
<i>Juga</i>	5	0.27
Acari	19	0.95
TOTAL: NON INSECTS	27	1.36
<i>Baetis tricaudatus</i>	48	2.44
<i>Attenella delantala</i>	40	2.04
<i>Drunella doddsi</i>	70	3.53
<i>Ephemerella inermis</i>	16	0.81
<i>Cinygmula</i>	8	0.41
<i>Epeorus</i>	121	6.11
<i>Ironodes</i>	11	0.54
<i>Rhithrogena</i>	925	46.68
<i>Paraleptophlebia</i>	5	0.27
TOTAL: EPHEMEROPTERA	1245	62.82
Capniidae	3	0.14
<i>Sweltsa</i>	5	0.27
<i>Zapada cinctipes</i>	145	7.33
<i>Hesperoperla pacifica</i>	11	0.54
<i>Cultus</i>	11	0.54
<i>Isoperla</i>	22	1.09
<i>Skwala</i>	3	0.14
<i>Yoraperla brevis</i>	3	0.14
<i>Pteronarcys californica</i>	3	0.14
TOTAL: PLECOPTERA	204	10.31
<i>Brachycentrus americanus</i>	8	0.41
<i>Glossosoma</i>	5	0.27
<i>Hydropsyche</i>	229	11.53
<i>Hydroptila</i>	3	0.14
<i>Lepidostoma-panel case larvae</i>	3	0.14
<i>Rhyacophila</i>	3	0.14
<i>Rhyacophila Betteni Group</i>	11	0.54
<i>Rhyacophila blarina</i>	3	0.14

Goldsborough Creek, Site 4, above weirs, Oct. 27, 2003, con't.

IDENTIFICATION CODE	03FR205
CORRECTION FACTOR	2.69

Taxon	Abundance	%
<i>Rhyacophila narvae</i>	13	0.68
<i>Rhyacophila pellisa/valuma</i>	8	0.41
TOTAL: TRICHOPTERA	285	14.38
<i>Heterlimnius</i>	27	1.36
<i>Narpus</i>	11	0.54
<i>Optioservus</i>	11	0.54
TOTAL: COLEOPTERA	48	2.44
Dolichopodidae	3	0.14
<i>Chelifera/Metachela</i>	5	0.27
<i>Glutops</i>	3	0.14
<i>Pericoma</i>	3	0.14
<i>Simulium</i>	16	0.81
<i>Antocha</i>	35	1.76
<i>Cryptolabis</i>	32	1.63
<i>Dicranota</i>	3	0.14
TOTAL: DIPTERA	100	5.02
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<i>Cladotanytarsus</i>	59	2.99
<i>Lopescladius</i>	5	0.27
<i>Micropsectra</i>	3	0.14
<i>Rheotanytarsus</i>	3	0.14
<i>Tanytarsus</i>	3	0.14
TOTAL: CHIRONOMIDAE	73	3.66
GRAND TOTAL	1983	100.00

Goldsborough Creek, Site 4, February 24, 2004

WA: Mason County, near Shelton, for R2 Resource Consultants, by ABA, Inc.

Benthic invertebrates, erosional habitat, D-frame net, 4 point, 8 ft², 500 u.

Abundances converted to a square meter basis. FILE: 04SR206

IDENTIFICATION CODE	04SR206
CORRECTION FACTOR	1.79

Taxon	Abundance	%
Nematoda	4	0.28
Oligochaeta	4	0.28
<i>Juga</i>	7	0.56
Acari	2	0.14
TOTAL: NON INSECTS	16	1.25
<i>Ameletus</i>	9	0.69
<i>Baetis tricaudatus</i>	132	10.28
<i>Dipheter hageni</i>	2	0.14
<i>Attenella delantala</i>	30	2.36
<i>Drunella coloradensis/flavilinea</i>	16	1.25
<i>Ephemerella inermis</i>	14	1.11
<i>Cinygmula</i>	220	17.08
<i>Epeorus</i>	30	2.36
<i>Epeorus longimanus</i>	38	2.92
<i>Rhithrogena</i>	39	3.06
TOTAL: EPHEMEROPTERA	532	41.25
Capniidae	2	0.14
Chloroperlidae	21	1.67
<i>Sweltsa</i>	11	0.83
Leuctridae	9	0.69
<i>Calineuria californica</i>	2	0.14
<i>Hesperoperla pacifica</i>	2	0.14
<i>Isoperla</i>	2	0.14
<i>Taenionema</i>	36	2.78
TOTAL: PLECOPTERA	84	6.53
<i>Micrasema</i>	2	0.14
<i>Glossosoma</i>	2	0.14
<i>Hydropsyche</i>	11	0.83
<i>Dicosmoecus gilvipes</i>	9	0.69
<i>Rhyacophila Betteri Group</i>	2	0.14
<i>Rhyacophila Brunnea/Vemna Group</i>	2	0.14

Goldsborough Creek, Site 4, Feb. 24, 2004, con't.

IDENTIFICATION CODE	04SR206
CORRECTION FACTOR	1.79

Taxon	Abundance	%
<i>Rhyacophila narvae</i>	11	0.83
<i>Rhyacophila pellisa/valuma</i>	23	1.81
<i>Neophylax</i>	263	20.42
TOTAL: TRICHOPTERA	324	25.14
<i>Cleptelmis addenda</i>	4	0.28
<i>Heterlimnius</i>	11	0.83
<i>Narpus</i>	11	0.83
<i>Optioservus</i>	4	0.28
TOTAL: COLEOPTERA	29	2.22
Ceratopogoninae	48	3.75
<i>Dixella</i>	2	0.14
<i>Chelifera/Metachela</i>	5	0.42
<i>Clinocera</i>	2	0.14
<i>Glutops</i>	4	0.28
<i>Prosimulium</i>	5	0.42
<i>Simulium</i>	57	4.44
<i>Antocha</i>	2	0.14
<i>Cryptolabis</i>	23	1.81
<i>Dicranota</i>	2	0.14
TOTAL: DIPTERA	150	11.67
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Chironomidae-pupae	7	0.56
<i>Cladotanytarsus</i>	18	1.39
<i>Eukiefferiella</i>	5	0.42
<i>Heleniella</i>	2	0.14
<i>Krenosmittia</i>	2	0.14
<i>Lopescladius</i>	7	0.56
<i>Micropsectra</i>	4	0.28
<i>Orthocladius</i>	36	2.78
<i>Pagastia</i>	2	0.14
<i>Parametriocnemus</i>	34	2.64
<i>Paraphaenocladius</i>	20	1.53
<i>Polypedilum</i>	2	0.14
<i>Rheocricotopus</i>	2	0.14
<i>Stempellinella</i>	4	0.28
<i>Thienemanniella</i>	2	0.14

Goldsborough Creek, Site 4, Feb. 24, 2004, con't.

IDENTIFICATION CODE	04SR206
CORRECTION FACTOR	1.79

Taxon	Abundance	%
<i>Thienemannimyia</i> Complex	4	0.28
<i>Tvetenia Bavarica</i> Group	5	0.42
TOTAL: CHIRONOMIDAE	154	11.94
GRAND TOTAL	1289	100.00

Goldsborough Creek, Site 5 at bridge, October 27, 2003

WA: Mason County, near Shelton, for R2 Resource Consultants, by ABA, Inc.

Benthic invertebrates, erosional habitat, D-frame net, 4 point, 8 ft2, 500 u.

Abundances converted to a square meter basis. FILE: 03FR207

IDENTIFICATION CODE	03FR207
CORRECTION FACTOR	1.79

Taxon	Abundance	%
Nematoda	2	0.16
Oligochaeta	84	7.30
<i>Juga</i>	20	1.71
<i>Crangonyx</i>	2	0.16
<i>Stygobromus</i>	2	0.16
<i>Pacifasticus</i>	2	0.16
Acari	11	0.93
TOTAL: NON INSECTS	122	10.56
<i>Octogomphus</i>	4	0.31
TOTAL: ODONATA	4	0.31
<i>Baetis tricaudatus</i>	5	0.47
<i>Caudatella hystrix</i>	2	0.16
<i>Drunella doddsi</i>	4	0.31
<i>Ephemerella inermis</i>	2	0.16
<i>Cinygmula</i>	5	0.47
<i>Epeorus</i>	7	0.62
<i>Ironodes</i>	2	0.16
<i>Rhithrogena</i>	175	15.22
<i>Paraleptophlebia</i>	5	0.47
TOTAL: EPHEMEROPTERA	208	18.01
Chloroperlidae	5	0.47
<i>Sweltsa</i>	16	1.40
<i>Zapada cinctipes</i>	20	1.71
<i>Hesperoperla pacifica</i>	2	0.16
Perlodidae	2	0.16
<i>Isoperla</i>	2	0.16
<i>Yoraperla brevis</i>	5	0.47
<i>Pteronarcella</i>	2	0.16
<i>Taeniopteryx</i>	11	0.93
TOTAL: PLECOPTERA	64	5.59
<i>Micrasema</i>	45	3.88
<i>Glossosoma</i>	7	0.62
<i>Hydropsyche</i>	7	0.62

Goldsborough Cr., Site 5 at bridge, Oct. 27, 2003, con't.

IDENTIFICATION CODE	03FR207	
CORRECTION FACTOR	1.79	
Taxon	Abundance	%
<i>Hydroptila</i>	4	0.31
<i>Psychomyia</i>	5	0.47
<i>Rhyacophila arnaudi</i>	4	0.31
<i>Rhyacophila Betteni Group</i>	2	0.16
<i>Rhyacophila blarina</i>	4	0.31
<i>Rhyacophila narvae</i>	23	2.02
<i>Rhyacophila pellisa/valuma</i>	2	0.16
TOTAL: TRICHOPTERA	102	8.85
<i>Cleptelmis addenda</i>	20	1.71
<i>Heterlimnius</i>	111	9.63
<i>Narpus</i>	18	1.55
<i>Optioservus</i>	326	28.26
<i>Zaitzevia</i>	38	3.26
<i>Brychius</i>	9	0.78
TOTAL: COLEOPTERA	521	45.19
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<i>Ceratopogoninae</i>	9	0.78
<i>Chelifera/Metachela</i>	5	0.47
<i>Glutops</i>	7	0.62
<i>Pericoma</i>	11	0.93
<i>Simulium</i>	73	6.37
<i>Antocha</i>	11	0.93
TOTAL: DIPTERA	116	10.09
<i>Cryptochironomus</i>	2	0.16
<i>Polypedilum</i>	5	0.47
<i>Stempellinella</i>	4	0.31
<i>Tanytarsus</i>	4	0.31
<i>Thienemannimyia Complex</i>	2	0.16
TOTAL: CHIRONOMIDAE	16	1.40
GRAND TOTAL	1153	100.00

Goldsborough Creek, Site 5, Carmen Road bridge, Feb. 24, 2004

WA: Mason County, near Shelton, for R2 Resource Consultants, by ABA, Inc.

Benthic invertebrates, erosional habitat, D-frame net, 4 point, 8 ft², 500 u.

Abundances converted to a square meter basis. FILE: 04SR208

IDENTIFICATION CODE	04SR208
CORRECTION FACTOR	3.58

Taxon	Abundance	%
Nematoda	36	1.23
Oligochaeta	32	1.10
<i>Pisidium</i>	11	0.37
<i>Margaritifera</i>	4	0.12
<i>Juga</i>	14	0.49
<i>Pacifasticus</i>	7	0.25
Acari	4	0.12
TOTAL: NON INSECTS	107	3.68
<i>Octogomphus</i>	14	0.49
TOTAL: ODONATA	14	0.49
<i>Baetis tricaudatus</i>	379	12.99
<i>Diphetor hageni</i>	11	0.37
<i>Drunella coloradensis/flavilinea</i>	11	0.37
<i>Ephemerella inermis</i>	18	0.61
<i>Cinygmula</i>	175	6.00
<i>Epeorus</i>	43	1.47
<i>Rhithrogena</i>	82	2.82
<i>Paraleptophlebia</i>	18	0.61
TOTAL: EPHEMEROPTERA	737	25.25
<i>Zapada cinctipes</i>	7	0.25
<i>Yoraperla brevis</i>	4	0.12
<i>Pteronarcys californica</i>	4	0.12
<i>Taenionema</i>	18	0.61
TOTAL: PLECOPTERA	32	1.10
<i>Micrasema</i>	11	0.37
<i>Glossosoma</i>	25	0.86
<i>Hydropsyche</i>	4	0.12
<i>Dicosmoecus gilvipes</i>	4	0.12
<i>Psychomyia</i>	4	0.12
<i>Rhyacophila Betteni</i> Group	11	0.37
<i>Rhyacophila blarina</i>	4	0.12
<i>Rhyacophila narvae</i>	18	0.61
<i>Rhyacophila pellisa/valuma</i>	4	0.12

Goldsborough Cr., Site 5, Carmen Rd. bridge, Feb. 24, 2004, con't.

IDENTIFICATION CODE	04SR208
CORRECTION FACTOR	3.58

Taxon	Abundance	%
<i>Neophylax</i>	14	0.49
TOTAL: TRICHOPTERA	97	3.31
<i>Cleptelmis addenda</i>	4	0.12
<i>Heterlimnius</i>	32	1.10
<i>Narpus</i>	4	0.12
<i>Optioservus</i>	233	7.97
<i>Zaitzevia</i>	36	1.23
TOTAL: COLEOPTERA	308	10.54
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<i>Glutops</i>	21	0.74
<i>Prosimulium</i>	369	12.62
<i>Simulium</i>	1124	38.48
<i>Antocha</i>	11	0.37
<i>Dicranota</i>	4	0.12
TOTAL: DIPTERA	1529	52.33
<i>Eukiefferiella</i>	21	0.74
<i>Eukiefferiella Devonica Group</i>	4	0.12
<i>Micropsectra</i>	7	0.25
<i>Orthocladius Complex</i>	7	0.25
<i>Pagastia</i>	4	0.12
<i>Parametriocnemus</i>	11	0.37
<i>Paratanytarsus</i>	4	0.12
<i>Polypedilum</i>	4	0.12
<i>Rheocricotopus</i>	4	0.12
<i>Stempellinella</i>	18	0.61
<i>Tanytarsus</i>	11	0.37
<i>Tvetenia Bavarica Group</i>	4	0.12
TOTAL: CHIRONOMIDAE	97	3.31
GRAND TOTAL	2921	100.00